



*Shelve in stacks  
S.B.T.*

# Highway Safety Literature

... A SEMI-MONTHLY ABSTRACT JOURNAL

## AVAILABILITY OF DOCUMENTS

Documents listed in **Highway Safety Literature** are **not** available from the National Highway Traffic Safety Administration. They must be ordered from the sources indicated on the citations, usually at cost. Ordering information for each of the sources is listed below.

**NTIS:** National Technical Information Service, Springfield, Va. 22151. **Order by title and accession number:** PB, AD, or HS.

**GPO:** Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. **Give corporate author, title, personal author, and report number.**

**Corporate author:** Contact corporate author.

**Reference copy only:** Consult your librarian.

**See serial citation:** Obtain through normal loan or purchase.

**SAE:** Society of Automotive Engineers, Dept. HSL, 2 Pennsylvania Plaza, New York, N.Y. 10001. **Order by title and SAE report numbers.**

**HRB:** Highway Research Board, National Academy of Sciences, 2101 Constitution Ave., N.W., Washington, D.C. 20418.

Material directly related to Highway and/or Motor Vehicle Safety is solicited for inclusion in Highway Safety Literature. Topics must fall within the scope of the mission of the National Highway Traffic Safety Administration. Submit material, together with a written statement of approval for publication to:

Office of Administrative Services (N48-50)  
National Highway Traffic  
Safety Administration  
400 7th Street, S.W.  
Washington, D.C. 20590

Please indicate availability source and price for the material.

**Special notice:** Material published in HSL is intended only for information. References to brand names, equipment

73-19

## SAMPLE ENTRIES

**JOURNAL ENTRY**

**Title of Document** { **SYNTHESIS OF CASE LAW JURISPRUDENCE RELATING TO WET-WEATHER HIGHWAY CONDITIONS**

**Journal Citation** → Highway Research Record n 376 p29-36 (1971)  
D. C. Oliver 1971

**Author(s)** → Sponsored by Highway Res. Board Steering Com. for Workshop on Anti-Skid Program Management and presented at the workshop.

**Search Terms** { Descriptors: \*Liability, \*Negligence, \*Accident responsibility, \*Legal responsibility, \*Wet road conditions, \*Court decisions, \*State government, \*Skidding accidents, \*Warning signs, \*Highway maintenance, \*Litigation, \*Icy road conditions,

**Abstract** { The extant case law on legal liability for accidents occurring on icy and wet highways has established three central areas and one subarea in the jurisprudence of maintenance liability. These areas are compliance with general duties in order to escape liability; damages resulting from noncompliance (negligence); contributory negligence as a bar to recovery; and advisory signing as a technique in meeting general duties. Court decisions covering these four areas are presented.

**NHTSA Accession Number** → HS-012 289  
\*Subject heading in Subject Index

**CONTRACT REPORT**

**EQUIPMENT AND PROCEDURES FOR MEASURING GLARE FOR MOTOR VEHICLES. FINAL REPORT**

**Corporate author** → Teledyne Brown Engineering  
N. E. Chatterton J. D. Hayes E. W. George 1972 102p  
Contract DOT-HS-089-1-139

**Availability** → NTIS

Descriptors: \*Glare, \*Glare reduction, \*Visual perception, \*Photometers, \*Luminance, \*Hydraulic equipment, \*Central vision, \*Field of view, \*Backgrounds, \*Contrast, \*Light conditions, \*Brightness, \*Test facilities, \*Test equipment, \*Vehicle safety standards, \*Simulators, \*Light, \*Reflectance, \*Measuring instruments,

A procedure and description of equipment for measuring glare from a driver's own vehicle are presented. The procedures are based on a disability glare theory as applied to foveal vision. Two pieces of apparatus were constructed to provide the measurement capability. One of them simulates diffuse sky glare and the other simulates direct solar glare. Methods of combining data from these measurements are presented along with scaling laws selected to provide a value for glare as it would be under natural daylight conditions. A standard for allowable glare levels from the vehicle is developed which is independent of the measurement procedure. Test results from a passenger car are presented and compared with this standard. Recommendations for improvements to the apparatus and additional research requirements for improvement to the theory are made.

HS-800 731

## 1B. Injuries

### A STUDY OF TRAFFIC CONFLICTS AT SIX INTERSECTIONS

Transport and Road Res. Lab. (England)  
For primary bibliographic entry see Fld. 1C.  
HS-013 174

## 1C. Investigation And Records

### A STUDY OF TRAFFIC CONFLICTS AT SIX INTERSECTIONS

Transport and Road Res. Lab. (England)  
B. R. Spicer TRRL-LR-551  
Corporate author

\*Traffic conflicts, \*Accident analysis, \*Accident research, \*Accident diagrams, \*Accident factors, \*Injury rates, \*Traffic flow, \*Accident location, \*Intersection collisions,

Serious conflict and injury accident frequencies are shown to be positively related between different junctions and between different locations within a given junction. These data validate the use of the traffic conflict technique as a relatively rapid method of study of junction safety. At each intersection studies of vehicle speed and flow have been made and the important influence on conflicts of vehicles other than those primarily involved has been shown.  
HS-013 174

### 1971 ANALYSIS OF MOTOR CARRIER ACCIDENTS INVOLVING VEHICLE DEFECTS OR MECHANICAL FAILURE

Bureau of Motor Carrier Safety

Corporate author

\*Failure caused accidents, \*Bus accidents, \*Truck accidents, \*Fatalities, \*Property damage accidents, \*Truck defects, \*Bus defects, \*Single vehicle accidents, \*Vehicle vehicle collisions, \*Injuries, \*Accident caused fires, \*Mobile homes, \*Driverless vehicles, \*Accident statistics, \*Defects,

Statistics were extracted from 57,746 reports submitted in 1971 by motor carriers who hold operating authority from the Interstate Commerce Commission and by carriers of exempt commodities subject to the Federal Motor Carrier Safety Regulations. Of the total number of accidents reported, 2,130, or 3.7%, involved mechanically defective vehicles. This number involved 1.7% of the number of fatalities, 3% of the injuries, and 7.1% of the property damage of the totals reported in 1971. For passenger carriers, the data base consists of 2,588 accidents reported of which 48, or 1.9%, involved defective vehicles which resulted in 1 fatality, 83 injuries, and nearly 264 thousand dollars in property damage. The property carriers data base consists of 55,158 reported accidents of which 2,082, or 3.8%, involved defective vehicles which resulted in 33 fatalities, 753 injuries, and over eight million dollars property damage. Truck rollover accidents and mobile home accidents are tabulated separately.  
HS-013 179

## MOTOR CARRIER ACCIDENT INVESTIGATION. ILLINOIS-CALIFORNIA EXPRESS, INC. ACCIDENT--JULY 24, 1972--PHOENIX ARIZONA

Bureau of Motor Carrier Safety  
72-8  
Corporate author

\*Failure caused accidents, \*Accident case reports, \*Accident causes, \*Accident investigation, \*Truck tires, \*Property damage accidents, \*Spare tires, \*Flying objects, \*Projectile impact, \*Fatalities, \*Phoenix,

On Interstate 17 at 12 noon, the spare tire and wheel fell from the carrier rack located under a tractor-semitrailer, bounced over the median wall, and struck the roof of an automobile. There were two fatalities and \$4,000 property damage. The cause of the accident was an improperly secured tire in the spare tire rack.  
HS-013 180

### MOTOR CARRIER ACCIDENT INVESTIGATION. TOMMIE C. KINARD AND LARRY L. RAMSEY AND METROPOLITAN FUELS CO., INC. ACCIDENT--APRIL 13, 1972--NEAR MERRIFIELD, VIRGINIA

Bureau of Motor Carrier Safety  
72-7  
Corporate author

\*Accident case reports, \*Tractor semitrailers, \*Tank trucks, \*Truck accidents, \*Drug caused accidents, \*Amphetamines, \*Multiple vehicle accidents, \*Accident investigation, \*Accident caused fires, \*Property damage accidents, \*Driver fatalities, \*Loss of control caused accidents, \*Driver characteristics,

At 9 a.m. on Interstate 495, a tractor semitrailer veered off the road, crossed the median strip, and struck a tractor cargo tank semitrailer. An automobile collided with the wreckage. Fire ensued. Results were one fatality, two injuries, and \$15,000 in property damage. Cause of the accident was loss of control by the tractor semitrailer driver who was under the influence of amphetamines.  
HS-013 181

## 2. HIGHWAY SAFETY

### 2G. Meteorological Conditions

#### AUTOMATED FUEL ROAD OCTANE RATINGS

American Oil Co.  
For primary bibliographic entry see Fld. 5F.  
HS-013 232

## 2H. Police Traffic Services

### RADAR AS A SPEED DETERRENT: AN EVALUATION

North Carolina Univ. Hwy. Safety Res. Center  
For primary bibliographic entry see Fld. 2I.  
HS-013 171

## 2I. Traffic Control

### RADAR AS A SPEED DETERRENT: AN EVALUATION

North Carolina Univ. Hwy. Safety Res. Center

## Field 2—HIGHWAY SAFETY

### Group 21—Traffic Control

D. W. Reinfurt D. N. Levine W. D. Johnson  
Corporate author

\*Radar, \*Speed indicators, \*North Carolina, \*Traffic law enforcement, \*Speed control, \*Police vehicles, \*Vehicle visibility, \*Traffic ticket systems, \*Police cooperation with other agencies, \*Public information programs, \*Mass media, \*Safety program effectiveness, \*Chi square test, \*Traffic law violations, \*Highway safety programs, \*Program evaluation, \*Reckless drivers, \*Speed studies,

Speeds of vehicles collected over an 11-day period in 43 North Carolina municipalities under varying experimental conditions (media publicity in one group of cities vs no publicity in a comparable group given baseline or before speeds for both groups) were examined to determine the effectiveness of radar, visibility of a patrol car, ticketing, and/or media publicity in eliminating or substantially reducing municipal speeding. In the 35 mph speed zones studied, a reduction in both the proportion of speeders (from 0.669 to 0.464) and the average speed of traffic (from 38.7 mph to 35.5 mph) can be accomplished by a combination of efforts such as visibility of the patrol vehicle, ticketing, and media publicity. However, each of the factors considered alone reflect only marginal evidence of effectiveness.  
HS-013 171

### A STUDY OF TRAFFIC CONFLICTS AT SIX INTERSECTIONS

Transport and Road Res. Lab. (England)  
For primary bibliographic entry see Fld. 1C.  
HS-013 174

### NEW INVESTIGATIONS OF EXHAUST GAS EMISSIONS OF MOTOR VEHICLE TRAFFIC

Trier-Kaiserlautern Univ. (West Germany)  
For primary bibliographic entry see Fld. 5F.  
HS-013 237

## 3. HUMAN FACTORS

### 3A. Alcohol

### LAW, SCIENCE, AND ACCIDENTS: THE BRITISH ROAD SAFETY ACT OF 1967

H. L. Ross  
Grant NSF-GS-30273X  
Reprinted from the Journal of Legal Studies, v11 n1 (Jan 1973).  
1155 East 60th Street, Chicago, Ill. 60637 \$0.50

\*Road Safety Act of 1967 (Great Britain), \*Blood alcohol levels, \*Drinking drivers, \*Driver intoxication, \*Alcohol breath tests, \*Accident statistics, \*Time series analysis, \*Injury rates, \*Fatality rates, \*Police law enforcement responsibilities, \*Safety program effectiveness, \*Convictions, \*Alcohol usage deterrents, \*Alcohol laws, \*Alcohol effects, \*Great Britain, \*Law enforcement effect on accident rates, \*Driver behavior,

This study provides support for the hypothesis that subjective certainty of punishment can deter socially harmful behavior as

HSL 73, No. 19

the Road Safety Act depends on overcoming organizational problems rather than on changing the formal rules, as currently suggested by many authorities in Britain. The principal method used is the study of statistical trends over time, employing interrupted time-series analysis where possible.  
HS-013 176

## 3D. Driver Behavior

### THE STATISTICAL ASSOCIATION BETWEEN PAST AND FUTURE ACCIDENTS AND VIOLATIONS

North Carolina Hwy. Safety Res. Center  
J. R. Stewart B. J. Campbell  
Corporate author

\*Accident risk forecasting, \*Driver records, \*Traffic law violations, \*Driver age, \*Time factors, \*High risk drivers, \*Statistical analysis, \*North Carolina, \*Correlation analysis, \*Age factor in accidents, \*Least squares method, \*Driver performance,

The predictability of future accidents in terms of past violations or accidents is investigated by observing a four-year history of accident and violation records of North Carolina drivers. The four-year driving history was divided into two adjacent time intervals, and the relationships were determined between accidents and violations. Driver age and the relative lengths of the two time periods are also considered. Past accidents are somewhat better predictors of future accidents than are past violations, in the sense of identifying high risk driver groups. In either case, however, the majority of all accidents occurring in a period of time (one, two, or three years) involve drivers having no accidents or violations in the previous period. Driver age seems to have little effect on the relationships between past and future driving performance although the performance of the youngest group of drivers seems to be slightly more unpredictable.  
HS-013 172

### THE HANDICAPPED AND THE DRIVING TASK

Oklahoma State Univ.  
For primary bibliographic entry see Fld. 3I.  
HS-013 189

### SIMULATION AND MEASUREMENT OF DRIVER VEHICLE HANDLING PERFORMANCE

Volkswagenwerk A.G. (West Germany)  
W. Lincke B. Richter R. Schmidt SAE-730489  
Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Driving simulators, \*Driver performance, \*Vehicle handling, \*Road tests, \*Driver behavior research, \*Yaw, \*Lane changing, \*Driver vehicle interface, \*Correlation analysis, \*Sideslip, \*Performance tests,

Correlations among the subjective evaluation of vehicle handling qualities, test measurements, and various characteristics

HS-013 195

**DEVELOPMENT OF MOTOR VEHICLE HANDLING PERFORMANCE REQUIREMENTS**

National Hwy. Traf. Safety Administration  
For primary bibliographic entry see Fld. 5R.  
HS-013 196

**3G. Drugs Other Than Alcohol**

**MOTOR CARRIER ACCIDENT INVESTIGATION.  
TOMMIE C. KINARD AND LARRY L. RAMSEY AND  
METROPOLITAN FUELS CO., INC. ACCIDENT--  
APRIL 13, 1972--NEAR MERRIFIELD, VIRGINIA**

Bureau of Motor Carrier Safety  
For primary bibliographic entry see Fld. 1C.  
HS-013 181

**3I. Impaired Drivers**

**CATEGORIZATION OF DISABILITIES AND  
FUNCTIONAL LIMITATIONS IMPOSED IN THE  
DRIVING TASK**

Texas A and M Univ.  
A. M. MayyasiP. E. PulleyW. A. HymanA. E. Swarts SAE-  
730466  
Presented at the Automobile Engineering Meeting, Detroit, 14-18  
May 1973.  
SAE

\*Amputees, \*Handicapped drivers, \*Vehicle design, \*Standardization, \*Driving tasks, \*Man machine systems,

The categorization of disabilities as they specifically relate to the driving task is elucidated and expanded using the example of amputees. Disabilities are assigned to the following categories: no amputation, amputation below the elbow or knee, amputation above the elbow or knee, and various combinations of multiple amputations. Automobiles and other man machine systems could be designed to accommodate the worst cases of amputees in each category and thus decrease the need for individualized assistive devices. A lengthy table detailing the categories of amputation is included and a discussion of the table in relation to driving an automobile is presented.

HS-013 188

**THE HANDICAPPED AND THE DRIVING TASK**

Oklahoma State Univ.  
M. D. Rhoads SAE-730467  
Presented at the Automobile Engineering Meeting, Detroit, 14-18  
May 1973.  
SAE

\*Handicapped drivers, \*Driving tasks, \*Automobile modification, \*Automobile design, \*Entering and leaving automobiles, \*Self help devices, \*Handicapped passengers, \*Public transportation usage, \*Driver performance, \*Driver physical fitness,

If possible, cars should be adapted with special controls for the handicapped that do not preclude the car being driven by the able-bodied family members. Existing optional equipment that will assist the handicapped in performing the driving task is described. To be completely independent, there are four additional tasks that the driver must perform: the one and a half hour

the normal driving requirements: he must be able to transfer himself and any assist device into the car, maintain proper body position and balance behind the wheel, skillfully operate special controls required by his condition, and transfer himself and any assist device out of the car. Records show that handicapped driver performance is very good. Handicapped persons seldom use public transportation because of fear for personal safety and long walking (wheel chair) distances.

HS-013 189

**A COMPLETE ONE-HANDED PISTOL-GRIP  
AUTOMOBILE CONTROLLER**

Texas A and M Univ.  
For primary bibliographic entry see Fld. 5D.  
HS-013 190

**COMPLETE SINGLE-FOOTED AUTOMOBILE  
CONTROLLER**

Texas A and M Univ.  
For primary bibliographic entry see Fld. 5D.  
HS-013 191

**ADVANCED CONCEPTS IN AUTOMOBILE DRIVER  
CONTROLS**

Rehabilitation Inst., Inc.  
For primary bibliographic entry see Fld. 5D.  
HS-013 192

**3K. Pedestrians**

**SCHOOL PEDESTRIAN COLLISIONS: ARE PUBLIC  
BELIEFS JUSTIFIED?**

San Diego County Engineer Dept.  
Jr., W. E. Marsden  
Corporate author

\*Child pedestrians, \*Age factor in accidents, \*Child injuries, \*Vehicle pedestrian collisions, \*Pedestrian age, \*Pedestrian behavior, \*Pedestrian education, \*Time of accidents, \*Time of day, \*Day of week, \*Injury severity, \*Accident responsibility, \*School bus accidents, \*Injuries by sex, \*Sex factor in accidents,

Reports were selected from files of accidents involving pedestrians between 5 and 15 years old, which occurred between 7 a.m. and 4 p.m. on school days. Slightly more collisions occurred on Fridays than on any other day. The majority of collisions occurred during early morning and late afternoon hours. Younger males were involved in the majority of the collisions. In 40 of the 53 cases reported, the pedestrian was found to be at fault. Less than 10% of the accidents occurred within one-quarter mile of the school.

HS-013 182

**4. OTHER SAFETY-RELATED AREAS****4A. Codes And Laws**

**LAWS, SCIENCE, AND ACCIDENTS: THE BRITISH  
ROAD SAFETY ACT OF 1967**

For primary bibliographic entry see Fld. 3A.  
HS-013 183

**RESEARCH IN CRASHWORTHINESS 2-  
MENTATION AND DATA HANDLING  
UES. INTERIM TECHNICAL REPORT**  
tp.  
bibliographic entry see Fld. 5D.

## **Mathematical Sciences**

**ER SIMULATION OF THE BRAKING AND  
G PERFORMANCE OF TRUCKS AND  
R-TRAILERS**  
bibliographic entry see Fld. 5T.

**OXIDES OF NITROGEN EMISSIONS  
ECTS OF EXHAUST GAS RECIRCULATION  
-IGNITION ENGINES**  
id. (Japan)  
bibliographic entry see Fld. 5F.

**OUS SECONDARY AIR MODULATION--ITS  
ON THERMAL MANIFOLD REACTOR  
ANCE**  
tors Corp.  
bibliographic entry see Fld. 5F.

**FILTERING FOR ANALYSIS OF  
RAL VIBRATIONS**  
tors Corp.  
bibliographic entry see Fld. 5D.

**INATION OF NATURAL FREQUENCIES  
E SHAPES OF CHASSIS FRAMES**  
bibliographic entry see Fld. 5D.

**OF AN AUTOMOTIVE FRAME TO  
NE DYNAMIC PROPERTIES**  
Co.  
bibliographic entry see Fld. 5D.

**ELEMENT DYNAMIC ANALYSIS OF AN  
TIVE FRAME**  
Co.  
bibliographic entry see Fld. 5D.

**ENTIAL URBAN VEHICLE**  
ashington State Coll.  
bibliographic entry see Fld. 5D.

**CONCEPT**  
Wisconsin Univ.  
For primary bibliographic entry see Fld. 5O.  
HS-013 212

**EVALUATION OF VEHICLE HANDLING AND  
STABILITY BY COMPUTER SIMULATION AT THE  
FIRST STAGE OF VEHICLE PLANNING**  
Toyo Kogyo Co. Ltd. (Japan)  
For primary bibliographic entry see Fld. 5R.  
HS-013 215

**SPRINGBACK ANALYSIS OF BIAXIALLY  
STRETCHED PANELS**  
Chrysler Corp.  
For primary bibliographic entry see Fld. 5D.  
HS-013 219

**INFUENCE OF VEHICLE DRIVING PATTERNS ON  
LOCALIZED URBAN EMISSIONS SOURCES**  
Imperial Coll. of Science and Technology (England)I18600  
For primary bibliographic entry see Fld. 5F.  
HS-013 238

**AN ENGINE DYNAMOMETER SYSTEM FOR THE  
MEASUREMENT OF CONVERTER PERFORMANCE**  
General Motors Corp.  
For primary bibliographic entry see Fld. 5F.  
HS-013 239

**CYCLE SIMULATION**  
Corning Glass Works  
For primary bibliographic entry see Fld. 5F.  
HS-013 241

**THE EFFECT OF VEHICLE STRUCTURE  
CHARACTERISTICS ON OCCUPANT RESTRAINT  
PARAMETERS. A PARAMETRIC STUDY.  
TECHNICAL REPORT**  
National Hwy. Traf. Safety Administration  
For primary bibliographic entry see Fld. 5N.  
HS-820 260

## **5. VEHICLE SAFETY**

### **5A. Brake Systems**

**COMPUTER SIMULATION OF THE BRAKING AND  
HANDLING PERFORMANCE OF TRUCKS AND  
TRACTOR-TRAILERS**  
For primary bibliographic entry see Fld. 5T.  
HS-013 175

**HYDRAULIC BRAKE ACTUATION SYSTEMS UNDER  
CONSIDERATION OF ANTILOCK SYSTEMS AND  
DISC BRAKES**

Teves (Alfred) G.m.b.H. (West Germany) T12900  
O. DepenheuerH Strien SAE-730535

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Hydraulic brakes, \*Hydraulic accumulators, \*Brake boosters, \*Brake system design, \*Power brakes, \*Disc brakes, \*Antilocking devices, \*Brake performance, \*Accumulator valves, \*Braking forces, \*Pedal force,

Three variations of hydraulic boosters for power-assisted brake systems and dual-circuit control valve for hydraulic full-power brake systems are described. The units all make use of the accumulator, for this offers the driver more security than the continuous-flow system. It has been suggested that brake systems be classified by means of an efficiency factor (total brake force/driver's pedal effort) and that an effectiveness coefficient be introduced as a comparison value to correlate the efficiency factor of a brake system having failed boosting with that of an intact system. Applying these values to brake systems using the described boosters helps judge the advantages and disadvantages and emphasized the importance of a new ZHS 2.2 booster, especially for heavier vehicles with disc brakes. A hydraulic actuation system is especially attractive when a vehicle is also to be equipped with antilocking devices.

HS-013 225

## HYDRAULICS OFFER ADVANTAGES IN POWER BRAKE BOOSTERS

Bendix Corp.  
A. K. Brown, L. G. Bach, D. J. Baker SAE-730536  
Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Hydraulic brakes, \*Power brakes, \*Brake boosters, \*Brake system design, \*Pressure, \*Hydraulic accumulators, \*Pedal force,

The use of hydraulics offers a power brake system that provides the higher pressures required to meet the new Federal Safety Stopping Distance Regulations for some passenger car and truck applications. The design and operating characteristics of the Bendix Hydro-Boost hydraulic power brake booster are explained. A ratio change feature that shortens the power stroke of the unit and multiplies the input motion at the valve, thus importing a responsive proportional feel to the brake, is achieved by this design. Minimal interaction between steering and braking is made possible by the valve design employed. The system allows utilization of full pump relief pressure which enhances the response characteristics of the system because the power piston diameter can be held to a minimum.

HS-013 226

## BRAKE AND CLUTCH EMISSIONS GENERATED DURING VEHICLE OPERATION

Bendix Res. Labs.  
For primary bibliographic entry see Flid. 5F.  
HS-013 231

## INDOOR VEHICLE BRAKING SIMULATION: CORRELATION AND COMPARISON WITH ROAD TESTING

Societe Anonyme Francaise du Ferodo (France) S20600  
J Odier SAE-730562

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Dynamometers, \*Ride Simulators, \*Test equipment, \*Brake tests, \*Simulation, \*Laboratory tests, \*Road tests, \*Brake performance, \*Torque, \*Braking forces, \*Vehicle safety standards,

The principle of a dynamometer that permits laboratory simulation of the road behavior of a passenger car under all conditions is briefly reviewed. The application of Federal Motor Vehicle Safety Standard 105 in correlating and comparing road test results with the simulator performance of a given car in braking activities is discussed. The simulator tests showed an excellent correlation with road testing and indicated that a better quality of testing is obtained with the simulator test bench. The simulator is especially advantageous for braking tests because measurements are more accurate and the tests are repeatable; braking distribution can be measured or recorded at each brake application; pivoting torque can be easily measured; braking in transient conditions can be studied at different levels of tire-surface adherence; and the longitudinal reaction of the ground on each tire can be measured in connection with the load transfer on the corresponding wheel.

HS-013 242

## BRAKE ROAD TESTING IN THE LABORATORY

Automotive Products Co. Ltd. (England)  
R. M. Oldershaw, A. F. Prestidge, R. C. Birkmyre SAE-730563  
Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Dynamometers, \*Brake lining tests, \*Brake thermal factors, \*Simulation, \*Laboratory tests, \*Road tests, \*Brake performance, \*Deceleration, \*Coefficient of friction, \*Disc brakes, \*Analog computers,

The high degree of correlation now attainable with practical vehicle test results, using a reduced-scale dynamometer is illustrated. The techniques for achieving this state of the art are described in relation to the parameters generally known to influence vehicle/laboratory correlation. As result of the investigation, the following additional parameters are submitted: history of pad use, correct temperature/time simulation of the car by the machine and rate of work input during a test. The simulation item is the subject of a special study in which the thermal conditions in a brake are examined on an analog computer by means of a 2 d.f. model. A discussion of the possible applications of the scale dynamometer leads to the conclusion that a machine could now be developed to provide meaningful data linings for the use of friction material, brake, and vehicle manufacturers, as well as legislators.

HS-013 243

## 5D. Design

## LOWERING DIESEL NOISE THROUGH HARDWARE MODIFICATIONS

V81 N6  
S. H. Jenkins, H. K. Kuehner  
Based on SAE-730681, Diesel-Engine Noise Reduction Hardware for Vehicle Noise Control.  
Automotive Engineering v81 n6 p41-7 (Jun 1973)



## Field 5—VEHICLE SAFETY

### Group 5D—Design

\*Diesel engine noise, \*Noise control, \*Vibration isolators, \*Sound absorbing materials, \*Damping, \*Shielding,

Isolation, damping, and shielding of individual components can reduce overall noise levels from 3-6 dBA. Test procedures and sound absorbing devices and materials are described.

HS-013 184

### DEVELOPMENT OF A LOW-EMISSION AND HIGH-PERFORMANCE 2-STROKE GASOLINE ENGINE (Nice)

Japan Automobile Res. Inst., Inc., J00900 Tokyo Univ. (Japan)  
S. H. JoP. D. JoT. GomiS. Ohnishi SAE-730463  
Presented at the Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Two stroke cycle engines, \*Exhaust emission control, \*Engine performance, \*Engine design, \*Engine tests, \*Cylinder gases, \*Gas motion, \*Fluid flow, \*Combustion chamber design, \*Lean fuel mixtures, \*Exhaust emission tests, \*Fuel consumption, \*Vibration, \*Knock, \*Afterburners, \*Deceleration, \*Braking, \*Idling,

An important advantage of the 2-stroke cycle gasoline engine is that its emission of nitrogen oxides is very low. Experimental models of this engine showed that its percentage of exhaust gas contaminants could be made sufficiently low to meet the specified 1976 standard. Proper control of gas flow into the cylinder produced smooth combustion at idling. Thus, in the experimental model described in this paper, the usual drawbacks of the conventional engine (vibration, noise, knocking) have been eliminated so that vibration, power output, and fuel consumption are comparable to those found in a 4-stroke engine, without using an exhaust treatment system.

HS-013 186

### THE PLASTIC CAR

Volkswagenwerk A.G. (West Germany)  
H. Habitzel SAE-730465  
Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Thermoplastics, \*Glass fiber reinforced plastics, \*Thermosetting resins, \*Polyester, \*Plastic foams, \*Automobile design, \*Automobile bodies, \*Energy absorbing materials, \*Tensile strength, \*Heat resistance, \*Deformation, \*Loading (mechanical), \*Manufacturing, \*Automobile costs, \*Impact tests, \*Automotive parts, \*Volkswagenwerk (West Germany),

The main area of plastic usage is the automobile body. Plastics are being already used for sound and heat insulation, upholstery, body trim, seals, armrests, handgrips, and sun visors. Accessory assemblies, covers, ducts, containers, and seals are candidates for plastic materials. In the areas where they have established themselves, plastics increase efficiency and durability of parts, decrease maintenance, beautify appearance, guarantee interior and exterior safety, prevent corrosion, increase well-being and comfort, and are economical. Plastics dis-

HS-013 187

### CATEGORIZATION OF DISABILITIES AND FUNCTIONAL LIMITATIONS IMPOSED IN THE DRIVING TASK

Texas A and M Univ.  
For primary bibliographic entry see Fld. 3I.  
HS-013 188

### THE HANDICAPPED AND THE DRIVING TASK

Oklahoma State Univ.  
For primary bibliographic entry see Fld. 3I.  
HS-013 189

### A COMPLETE ONE-HANDED PISTOL-GRIP AUTOMOBILE CONTROLLER

Texas A and M Univ.  
A. M. MayyasiP. E. PulleyA. E. Swarts SAE-730469  
Presented at the Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Self help devices, \*Handicapped drivers, \*Vehicle control, \*Automobile modification, \*Steering wheel design, \*Control equipment, \*Amputees, \*Human factors engineering,

A one-handed pistol-grip controller which attaches to the steering wheel has been designed to control manipulation of the steering wheel, brakes, lights, horn, windshield wipers, windows, radio, temperature control, turn signals, and accelerator. This assistive device will not interfere with the normal operation of the vehicle but will enable the disabled individual safely to operate the same vehicle.

HS-013 190

### COMPLETE SINGLE-FOOTED AUTOMOBILE CONTROLLER

Texas A and M Univ.  
A. M. MayyasiP. E. PulleyA. E. Swarts SAE 730470  
Presented at the Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Self help devices, \*Handicapped drivers, \*Control equipment, \*Automobile modification, \*Pedals, \*Amputees, \*Paraplegia, \*Human factors engineering,

The control logic of a single-footed automobile controller (SFC) is described. Intended for use by handicapped drivers, the controller can control the transmission control sequence, turn signals, steering wheel, brakes, horn, accelerator, and auxiliary controls. The single-footed controller was developed basically for the amputee with one good leg. The mechanics and logic of the SFC can be modified into several types of lap board controls for use by paraplegics or quadriplegics. When the vehicle is operated by a normal driver, all special systems are deactivated by the insertion of the ignition key.

HS-013 191

Presented at the Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Self help devices, \*Handicapped drivers, \*Automobile modification, \*Human factors engineering, \*Power brakes, \*Brake boosters, \*Vacuum brakes, \*Brake system design, \*Power steering systems, \*Gear shifting, \*Headlamp dimmer switches, \*Acceleration control, \*Control equipment,

Finger operated driver controls which connect directly to the carburetor and power brake servo valve offer driving ability to the handicapped not able to operate conventional hand controls. Mechanical servo connections eliminate the need for pushrod and level connections to the foot pedals. Use of a set of control modules with the direct connections offers all drivers a safe and versatile control system requiring much less effort and range of motion. Safety results from smooth positive control action and from an auxiliary power backup system. Versatility results from the direct connections and low effort and travel required by this new system. Optimum feel is obtained by proper combination of the force and displacement feedback loops built into the system connections. Operation of power brake, accelerator, dimmer switch, shift selector, and power steering controls is outlined, and a pistol grip control design is discussed. Auxiliary controls may also be added.

HS-013 192

## DIGITAL FILTERING FOR ANALYSIS OF STRUCTURAL VIBRATIONS

General Motors Corp.

D. F. Malen E. A. Vaughan SAE-730503

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Structural dynamics, \*Body design, \*Dynamic structural analysis, \*Vibration tests, \*Time series analysis, \*Dynamic tests, \*Mathematical models, \*Computerized simulation, \*Simulation models, \*Fourier analysis, \*Stress analysis, \*Scale models,

The objectives of the system are explained, mathematical properties are derived, and system operation is discussed with respect to hardware, characteristics, and sample output. This method for digital filtering of time series data has proved to be fast, effective, and an easily implemented method of analyzing structural properties. In addition to providing the design engineer with all of the traditional forms of output offered by analog systems, the computer-based nature of the digital filter system facilitates the use of large-scale dynamic simulations requiring mode identification and other analytical software.

HS-013 204

## DETERMINATION OF NATURAL FREQUENCIES AND MODE SHAPES OF CHASSIS FRAMES

Budd Co.

R. J. George SAE-730504

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Frame design, \*Frame tests, \*Vibration analysis, \*Vibration tests, \*Resonant frequency, \*Model tests, \*Scale models, \*Bending, \*Torsional vibration, \*Mathematical models, \*Com-

The objective of this paper was to establish the degree of correlation between the results obtained from a 3/8 scale plastic model, an actual frame, and a mathematical computer model. Results showed that a satisfactory dynamic simulation can be obtained from a scaled plastic model of the structure and that a mathematical model composed of beam elements is accurate at the lower frequencies but begins to differ with the actual frame at higher frequencies.

HS-013 205

## TESTING OF AN AUTOMOTIVE FRAME TO DETERMINE DYNAMIC PROPERTIES

Ford Motor Co.

D. L. Flanigan SAE-730505

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Frame tests, \*Frame design, \*Vibration tests, \*Structural dynamics, \*Vibration analysis, \*Dynamic structural analysis, \*Resonant frequency, \*Mathematical models, \*Curve fitting, \*Computerized test methods, \*Test equipment,

The essentially modal behavior of an automotive chassis frame in the 0-30 Hz frequency range is confirmed by investigation of a typical frequency response. A mathematical model is developed for which the parameters are to be obtained directly by analysis of vibration test data. The requirements are determined for the instrumentation system and laboratory test setup necessary to obtain accurate estimates of resonant frequencies, mode shapes, and modal mass and damping properties. The determination and importance of the rigid body properties and the residual compliance of truncated modes are discussed. Direct comparisons of predicted frequency responses with the original test data demonstrate the validity of the test-derived model.

HS-013 206

## FINITE ELEMENT DYNAMIC ANALYSIS OF AN AUTOMOTIVE FRAME

Ford Motor Co.

V. J. Borowski R. L. Steury J. L. Lubkin SAE-730506

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Frame design, \*Finite element method, \*Dynamic structural analysis, \*Vehicle dynamics, \*Shear stress, \*Deformation analysis, \*Torsional vibration, \*Rigidity, \*Joints, \*Resonant frequency, \*Computerized simulation, \*Computer programs, \*Moments of inertia, \*Frequency tests,

Small improvements in accuracy were noted when higher-order mass representation and allowance for shear deformation were included in the analysis. Modeling accuracy was significantly increased, however, by including certain effects which are normally ignored. These include an allowance for the less-than-perfect rigidity of side-rail-to-cross-member joints; for the torsional behavior of short, open cross-section beams; and for the reduction of flexural inertia in welded, double-channel cross-sections. With the introduction of these factors, the predicted natural frequencies for the first eight flexural modes can be correlated with test results to within 4%. For this level of agreement, the finite element model appears to be sufficiently accurate to be used in design evaluation of frames prior to prototype construction.

**Group 5D—Design**

HS-013 207

**THE UCLA HYDROGEN CAR: DESIGN, CONSTRUCTION, AND PERFORMANCE**

California Univ., Los Angeles

For primary bibliographic entry see Fld. 5F.

HS-013 208

**URBAN VEHICLE DESIGN COMPETITION--A PRACTICE IN DESIGN**

Detroit Univ.

A. C. Haman M. Critz SAE-730508

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.

SAE

\*Urban automobiles, \*Automobile design, \*Automobile modification, \*Safety design, \*Exhaust emission control, \*Vehicle length, \*Vehicle width, \*Energy absorbing bumpers, \*Drivelines, \*Chassis design, \*Body design, \*Ford Maverick,

A 1970 Ford Maverick was modified for urban driving by Detroit University engineering students. The Maverick was shortened approximately five feet to a final length of 121 inches and widened one foot to a width of 80 inches. Features included 5 mph bumpers, an automatic transmission, a stratified charge engine, an offset driveline, high level exterior lighting, side door beams, three occupant capacity, a roll bar, front disc brakes, and an electrically driven fan for a cooling system. This urban vehicle design concept was awarded sixth place overall, and the top awards in safety and emissions for liquid fueled internal combustion engines in the 1972 Intercollegiate Urban Vehicle Design Competition.

HS-013 209

**EXPERIMENTAL URBAN VEHICLE**

Western Washington State Coll.

M. R. Seal SEA-730509

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.

SAE

\*Urban automobiles, \*Experimental automobiles, \*Automobile design, \*Midengine automobiles, \*Steering system design, \*Automobile performance, \*Rear suspension systems, \*Loading (operator performance), \*Linkages, \*Pedals, \*Flexible steering columns, \*Chassis design, \*Brake system design, \*Engine modification, \*Propane, \*Door systems, \*Body design, \*Passenger compartments, \*Energy absorbing bumpers, \*Energy absorbing materials, \*Bumper design, \*Steering, \*Turning radius, \*Mathematical analysis,

The experimental urban car designed and built by Western Washington State College includes a midengine rear drive chassis and a pyramid link rear suspension. Extreme Ackerman steering allows a nine foot turning radius. New systems were developed for adjustable pedals, steering, and seat squab height. The chassis quick-disconnects into three sections to facilitate servicing. A bias beam brake linkage allows easy adjustment of front-rear brake bias. The low emission engine runs on propane and is equipped with a thermal reactor and an exhaust gas recirculation system. The chassis center unit is made from epoxy fiberglass surface aluminum honeycomb. Passive restraint seat belts are attached to semigull wing doors. Five crash bumpers, crumple zones, and a front air curtain exterior

bolts and the spare tire; the rear uses beverage cans in compression. A headrest window provides whiplash protection while the Ensolite foam-covered dash protects against impact.

HS-013 210

**PROTOTYPE URBAN TAXI: A NEW APPROACH**

Society of Arts and Crafts

D. R. Taylor F. D. Coates SAE-730510

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.

SAE

\*Urban automobiles, \*Taxicabs, \*Automobile design, \*Experimental automobiles, \*Human factors engineering, \*Prototypes, \*Chassis design, \*Drivelines, \*Diesel engines, \*Exhaust emission control, \*Body design, \*Passenger compartments, \*Visibility, \*Handicapped passengers, \*Safety design, \*Crashworthy bodies, \*Aesthetics,

A team of industrial design students designed and built a prototype urban taxi that overcomes several disadvantages of contemporary production taxis including: inadequate interior driver and passenger space, bulky exterior dimensions, and inconvenience to physically handicapped passengers. The vehicle employs a diesel powerplant in the interest of operating economy, reliability, and decreased air pollution. The body, consisting of flat panels fastened to a simple steel roll-cage, is suited to low volume production and simple maintenance. Aesthetically, the vehicle was designed to harmonize visually with the urban environment.

HS-013 211

**THE UNIVERSITY OF MICHIGAN URBAN VEHICLE**

Michigan Univ.

D. W. Chicovsky T. G. Chicovsky J. A. Roby C. P. Theodore

SAE-730512

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.

SAE

\*Urban automobiles, \*Experimental automobiles, \*Automobile design, \*Wankel engines, \*Drivetrains, \*Chassis design, \*Safety design, \*Frames, \*Exhaust emission control, \*Suspension system design, \*Steering system design, \*Brake system design, \*Energy absorbing bumpers, \*Bumper design, \*Alcohol detection and interlock systems, \*Field of view, \*Passenger compartments, \*Crashworthy bodies, \*Occupant protection, \*Restraint system design, \*Rear engine automobiles, \*Compact automobiles, \*Body design,

The design and construction of a small, low cost, Wankel-powered, rear engine, rear-drive urban vehicle by engineering and industrial design students is outlined. The goal of this group was to submit a competitive entry to the Urban Vehicle Design Competition conducted in August 1972, and hopefully to provide some fresh solutions to the problems of urban transportation. Constraints set by the UVDC Committee as well as proposed federal emission and safety standards were considered as governing parameters in the design process. This report describes some of the many features of the University of Michigan entry and includes a discussion of the primary merits of the project. Safety features of the vehicle included 5 mph energy absorbing bumpers, an alcohol detection and interlock system, a crashworthy body, a seat belt and a rear air curtain

yoke shoulder harness, passenger compartment padding, a high seating position and large glass area, and improved lighting.  
HS-013 213

## RESULTS OF 1972 URBAN VEHICLE DESIGN COMPETITION

Student Competitions on Relevant Engineering, Inc.  
C. M. McCuen/M. S. Matthews SAE-730513  
Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Urban vehicles, \*Proving ground tests, \*Competition, \*Vehicle design, \*Performance tests, \*Hydrogen fuels, \*Exhaust emission control, \*Exhaust emission control devices, \*Electric vehicles, \*Hybrid vehicles, \*Wankel engines, \*Alcohol detection and interlock systems, \*Theft prevention devices, \*Field of view, \*Energy absorbing bumpers, \*Energy absorbing materials, \*Frames, \*Crash distance, \*Crashworthiness, \*Safety design, \*Steering systems, \*Vehicle size, \*Exhaust emission tests, \*Exhaust emission standards, \*Taxicabs, \*Automobile costs, \*Vehicle handling, \*Parking, \*Vehicle control, \*Barrier collision tests, \*Low speed impact tests, \*Fuel economy, \*Vehicle performance, \*Experimental automobiles,

In August 1972, the Union Vehicle Design Competition (UVDC) completed an 18-month program of vehicle design and construction with a national testing event of all vehicles entered in the contest. Sixty-six vehicles from 62 universities in the United States and Canada competed. The objectives of the competition were to promote a project-oriented approach to engineering education, and to provide students with the opportunity to contribute constructively in the effort to develop low-emission safe urban vehicles. Some of the more innovative designs appeared in the following areas: low-pollution powerplants utilizing nonfossil fuels, thermal reactors, catalytic reactors, exhaust gas recirculation systems, and hybrid powerplants; drunk tester/antitheft devices; bumper systems capable of protecting a vehicle from damage in a 5 mph impact; and overall integration of automotive systems in small vehicle design. A description of UVDC testing procedures, scoring results, and innovative designs is included.  
HS-013 214

## COLD-ROLLED HIGH-STRENGTH STEELS FOR AUTOMOTIVE APPLICATIONS

Molybdenum Corp. of America  
J. M. Gray SAE-730527  
Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Cold rolling, \*Steels, \*Sheet metal, \*Automobile materials, \*Strain rate, \*Yield strength, \*Corrosion resistance, \*Annealing, \*Surface treatment, \*Particle size, \*Vanadium, \*Columbium, \*Tensile strength, \*Welding, \*Hardening, \*Materials tests,

Solid solution hardening, precipitation hardening, grain refinement, and dislocation substructure can be used to varying extents to strengthen partially or fully recrystallized sheets. Yield strengths ranging 45-100 ksi (310-690MPa) and higher appear to be technically feasible, and steels with yield strengths up to 65 ksi (450MPa) are close to commercial production. The average

somewhat higher (1.0-1.35) than for similar hot-rolled steels but still relatively poor when compared to low-strength aluminum killed deep drawing sheet. The forming limit curves and forming performance of cold-rolled sheet are similar to hot-rolled high-strength steels indicating that less severe part design, improved die design, improved lubrication and shop practice, and control of steel cleanliness and sulfide shape will be essential if the new steels are to be properly exploited in automobile parts.  
HS-013 217

## DENT RESISTANCE OF COLD-ROLLED LOW-CARBON STEEL SHEET

United States Steel Corp.  
Jr., T. E. Johnson/W. O. Schaffnit SAE-730528  
Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Carbon steels, \*Cold rolling, \*Deformation analysis, \*Indenters, \*Yield strength, \*Sheet metal, \*Tensile strength, \*Strain rate, \*Impact tests, \*Dynamic tests, \*Plastic strain, \*Automobile materials, \*Damage severity, \*Impact forces, \*Thickness, \*Mathematical analysis,

Sheet samples, ranging in thickness from 0.024-0.061 inches and in yield strength from 21.8-68 ksi, were indented in a small-scale drop-weight tester. The relative dent resistance of the sheets was determined both by comparing dent depths at a particular impact energy and by comparing the impact energies required to produce dents of a particular size. By either criterion of dent resistance, the results of this study show that the dent resistance of cold-rolled low-carbon steel sheets is proportional to the product of the yield strength and the square of the thickness.  
HS-013 218

## SPRINGBACK ANALYSIS OF BIAXIALLY STRETCHED PANELS

Chrysler Corp.  
D. G. Adams/A. S. Kasper/G. M. Kurajian SAE-730529  
Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Automobile materials, \*Body design, \*Stress strain characteristics, \*Tensile strength, \*Automobile bodies, \*Elasticity, \*Computerized design, \*Computer programs, \*Iteration, \*Dies, \*Statistical analysis, \*Shear stress, \*Plastic strain,

A theoretical analysis procedure is developed on the basis of known and accepted stress and strain equations. Concurrently, requirements are presented for the construction of a computer program employing iterative techniques, necessary for solution of the problem. The analysis and program are employed to predict springback in several laboratory panels. Analysis procedure and accompanying computer program results are compared with experimental data which confirms the analysis. This procedure provides a valid prediction for overcrowning on the subsequent design of panel draw dies.  
HS-013 219

## A SERVO VEHICLE DRIVER FOR EPA EMISSION TESTS

General Motors Corp.  
A Levijokil Ayres YuM Hammel SAE-730532  
Presented at Automobile Engineering Meeting, Detroit, 14-18  
May 1973  
SAE

\*Servomechanisms, \*Electronic devices, \*Chassis dynamometers, \*Automatic control, \*Computerized test methods, \*Exhaust emission tests, \*Integrated circuits, \*Amplifiers, \*Performance characteristics,

An electronic servo controller, combined with an electric chassis dynamometer and a synchronized mini-computer generated command signal, provides consistent and smooth driving of development vehicles on Environmental Protection Agency emission runs. The electronic controller provides the necessary signals to actuate the throttle servo to power the engine, and to generate braking torque on the chassis rolls of the electric dynamometer. The servo gain and compensation circuits allow accurate and stable operation over a wide range of engine loads, transmission gear ratios, and car speeds. A single gain-compensation network is sufficient for vehicles used in General Motors' catalytic converter development program. Safety shutdown circuits and ease of installation are provided in the design.

HS-013 222

## PROPERTIES OF EPDM COMPOUNDED FOR MAXIMUM HEAT RESISTANCE

Goodrich (B. F.) Chemical Co.  
P. H. Rowe J. H. Sudekum K. C. Baranwal SAE-730540  
Presented at Automobile Engineering Meeting, Detroit, 14-18  
May 1973.  
SAE

\*Ethylene propylene terpolymer, \*Heat resistance, \*Curing. Aging, \*Temperature endurance tests, \*Sulfur, \*Peroxides, \*Tensile strength, \*Elongation, \*Hardness,

Design changes in new model cars have resulted in higher under-the-hood temperatures. This has created a demand for rubber components that are more heat resistant. Since ethylene propylene terpolymer (EPDM) is a heat and weather resistant polymer being considered for many of these applications, the effect of various cure systems on heat resistance of EPDM compounds is examined. The common sulfur cure system is useful to 300 F and the use of sulfur donor system can extend that range to 350 F. Above 350 F a peroxide cure is shown to be necessary.

HS-013 229

## SPUTTERING AND ION PLATING AS INDUSTRIAL PROCESSES

Hohman Plating and Mfg., Inc.  
B. C. Stupp SAE-730547  
Presented at Automobile Engineering Meeting, Detroit, 14-18  
May 1973.  
SAE

\*Plating, \*Sputtering, \*Ionization, \*Coating, \*Wear tests,

Ion plating and sputtering offer materials engineers versatile coating methods. Both processes use a controlled pressure chamber and vacuum equipment. Sputtering is essentially a line of sight deposition method. During ion plating the coating material is partially ionized, following electrical lines of force,

uniformly coating the substrate configuration. Sputtered molybdenum disulfide films on precision parts offer excellent lubrication without appreciably affecting tolerances. The ion plating process gives coatings of high density, free of porosity, and with excellent adhesion. The applications of both processes are discussed. Although the processes are not economically competitive with electroplating or other conventional coating methods, the properties they provide may offset the costs.

HS-013 230

## BASIC RESEARCH IN CRASHWORTHINESS 2--STRUCTURAL MODIFICATIONS OF SUBCOMPACT CARS FOR FRONTAL IMPACTS. INTERIM TECHNICAL REPORT

Calspan Corp.  
Jr., M. O. Ryder YB-2987-V-10  
Contract FH-11-7622  
NTIS

\*Crashworthiness, \*Compact automobiles, \*Structural design, \*Automobile modification, \*Head on impact tests, \*Pole impact tests, \*Vehicle vehicle impact tests, \*Front structures, \*Restraint system tests, \*Restraint system effectiveness, \*Air bag restraint systems, \*Three point restraint systems, \*Energy absorption, \*Deceleration, \*Structural analysis, \*Acceleration, \*Limit analysis, \*Plastic flow, \*Acceleration response, \*Impact velocity, \*Kinetic energy, \*Crash phase, \*Anthropometric dummies, \*Occupant kinematics, \*Test facilities, \*Test equipment, \*Chevrolet Vega, \*Crushing, \*Buick Opel,

Results from a series of frontal impact experiments on subcompact automobiles are presented. Front structure modifications were designed, fabricated, and tested. Both unmodified and structurally modified Chevrolet Vegas were tested in single vehicle pole barrier impacts at 60 mph and vehicle vehicle head on impacts at 40 mph. Crash energy dissipation occurred in plastic flow of material resulting from the bending moment distributions in the structural components. Structural steel rectangular tubing and hot rolled steel sheet stock were employed in the structural modifications. The lightest modification used in this program resulted in approximately a 320 lb. net weight increase. Most of the crash tests included simulated front seat occupants and either active or passive restraint systems. This secondary effort was intended to provide data on the functional characteristics of belt and air cushion restraint systems at the relatively high impact speeds of these tests.

HS-800 864

## BASIC RESEARCH IN CRASHWORTHINESS 2--INSTRUMENTATION AND DATA HANDLING TECHNIQUES. INTERIM TECHNICAL REPORT

Calspan Corp.  
A. R. Trenka YB-2987-V-5  
Contract FH-11-7622  
NTIS

\*Crashworthiness, \*Impact tests, \*Data acquisition, \*Instrumented vehicles, \*Data reduction, \*Test facilities, \*Data processing, \*Test equipment, \*Accelerometers, \*Sensors, \*Strain gauges, \*Tape recorders, \*High speed photography, \*Computer programs, \*Signal conditioners, \*Calibration, \*Frequencies, \*Amplitude modulation, \*Acceleration, \*Loads (forces), \*Flow charts, \*Electric systems,

The test facilities, instrumentation, and the data acquisition, recording, handling, and reduction techniques developed and employed on the Basic Research in Crashworthiness Program are described. Some typical results are briefly discussed. It is recommended that the effort on monitoring, updating, and evaluating crash test data and techniques should be continued in all subsequent crash test programs and that a more extensive study of the data available on the Crashworthiness Program be made to more clearly define those questions only partially answered at this point, namely: location and number of accelerometers required to define an impact; nature of the filtering which should be allowed; and identification of the principal characteristics of the crash impulse.

HS-800 865

### THE EFFECT OF VEHICLE STRUCTURE CHARACTERISTICS ON OCCUPANT RESTRAINT PARAMETERS. A PARAMETRIC STUDY. TECHNICAL REPORT

National Hwy. Traf. Safety Administration  
For primary bibliographic entry see Fld. 5N.  
HS-820 260

## 5F. Fuel Systems

### A SURVEY OF HYDROGEN'S POTENTIAL AS A VEHICULAR FUEL

California Univ., Livermore  
A. L. Austin UCRL-51228  
NTIS

\*Hydrogen fuels, \*Engine conversion, \*Energy consumption, \*Fuel consumption, \*Gasoline shortages, \*Oil consumption, \*Energy conservation, \*Air pollution measurement, \*Exhaust emission control, \*Air fuel ratio, \*Fuel systems, \*Metal hydrides, \*Magnesium, \*Fuel volatility, \*Fuel economy, \*Mileage range, \*Manufacturing, \*Forecasting, \*Fuel properties,

By 1980, the demand for petroleum to fuel the transportation market alone is expected to exceed the domestic supply. The fact that transportation is 96% dependent on petroleum and is a major source of pollution has impelled development of a clean engine and/or alternative clean fuels for vehicular use, among them hydrogen. The problems and potential of various hydrogen-based mobile fuel systems and the likely economic impact of a nationwide conversion to hydrogen are examined. The basic technical problem is to store enough hydrogen per vehicle in a small enough volume. The prospects for using gaseous and liquid hydrogen with air, liquid hydrogen with liquid oxygen, and hydrogen stored in metal hydrides in an internal combustion engine are analyzed. The practical feasibility is found to be marginal but with enough potential to justify ongoing research.

HS-013 173

### ARE WE RUNNING OUT OF GAS?

Federal Hwy. Administration  
L. L. ListonJ. E. Ullman  
Presented at the annual meeting of the North American Gasoline Tax Conference, Biloxi, Miss., 23 Oct 1972.  
Corporate author

United States demand for petroleum products in 1971 was 5.55 billion barrels, with nearly 42% being used for highway transportation. The average yearly increase of 4% projects a need for 9.6 billion barrels by 1985. If demand continues to increase and no new discoveries are made, the known reserves will be exhausted in 1981. Supply will have to be met by increasing imports, development of shale oil reserves, development of alternate propulsion systems, and by reduced demands through the use of smaller engines.

HS-013 178

### LET'S TAKE A NEW LOOK AT AUTOMOTIVE POLLUTION

V87 N6  
C. G. Burck  
Fortune v87 n6 p118-23, 248, 250, 252-3 (Jun 1973)

\*Carbon monoxide, \*Hydrocarbons, \*Nitrogen oxides, \*Vehicle air pollution, \*Air quality standards, \*Automotive industry, \*Catalytic converters, \*Exhaust emission control costs, \*Exhaust emission standards, \*Air pollution control,

Federal air quality standards are discussed, with the recommendation that strict controls be imposed for densely populated areas and relatively mild controls elsewhere. Costs of pollution control equipment have so far not been excessive but costs of meeting federal standards for 1976 may add more than \$500 to the retail price of a new car. The technical problems involved in designing an automotive pollution control device for all types of pollutants are discussed.

HS-013 183

### DEVELOPMENT OF A LOW-EMISSION AND HIGH-PERFORMANCE 2-STROKE GASOLINE ENGINE (Nicc)

Japan Automobile Res. Inst., Inc., J00900 Tokyo Univ. (Japan)  
For primary bibliographic entry see Fld. 5D.  
HS-013 186

### AN EVALUATION OF THE PERFORMANCE AND EMISSIONS OF A CFR ENGINE EQUIPPED WITH A PRECHAMBER

Phillips Petroleum Co.  
D. B. WimmerR. C. Lee SAE-730474  
Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Precombustion chamber engines, \*Spark ignition engines, \*Exhaust emission measurement, \*Engine tests, \*Lean fuel mixtures, \*Engine performance, \*Fuel consumption, \*Aldehydes, \*Octane requirements, \*Warmup, \*Carbon monoxide, \*Hydrocarbons, \*Engine operating conditions, \*Knock, \*Performance tests,

An experimental study of a naturally aspirated, spark-ignited prechamber mounted in a CFR engine demonstrated that this system provides a marked improvement in lean-mixture combustion both before and after engine warm-up. A premixed fuel-air mixture containing five times the stoichiometric amount of fuel was supplied to the prechamber at a rate of 2% of the main chamber mixture flow. The fuel-rich flame issuing from the prechamber provided an ignition source capable of igniting main chamber mixtures much leaner than those normally ignitable by the standard spark plug. The prechamber

**Group 5F—Fuel Systems**

HS-013 193

**PREDICTING OXIDES OF NITROGEN EMISSIONS AND EFFECTS OF EXHAUST GAS RECIRCULATION IN SPARK-IGNITION ENGINES**

Komatsu Ltd. (Japan)

K. Komiya, J. B. Heywood SAE-730475

Grant NSF-GK-15409

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.

SAE

\*Spark ignition engines, \*Nitrogen oxides, \*Lean fuel mixtures, \*Rich fuel mixtures, \*Exhaust gas recirculation, \*Nitric oxide, \*Exhaust emission measurement, \*Engine operating conditions, \*Mathematical models, \*Thermodynamic properties, \*Air fuel ratio, \*Ignition delay, \*Fuel flow, \*Spark timing, \*Crank angle, \*Unburned fuels, \*Cylinder pressure, \*Fuel combustion,

An improved theoretical model that predicts the nitric oxide concentration in the exhaust of a spark-ignition engine has been evaluated over a wide range of fuel-air ratios, percentage of exhaust gas recycled, and engine speed. Experiments were carried out in a standard CFR single-cylinder engine. Comparison of the measured and calculated exhaust nitric oxide concentrations shows good agreement over all operating conditions. It is shown that in lean mixtures, nitric oxide concentrations freeze early in the expansion stroke. For rich mixtures, freezing occurs later after all the charge has been burned and substantial nitric oxide decomposition takes place. In addition, effects of exhaust gas recirculation on flame speed, ignition delay, and cycle-to-cycle pressure variations were evaluated. A simple model relating cycle-to-cycle variations with changes in ignition delay is presented.

HS-013 194

**CONTINUOUS SECONDARY AIR MODULATION—ITS EFFECT ON THERMAL MANIFOLD REACTOR PERFORMANCE**

General Motors Corp.

D. J. Poznanski, R. M. Siewert SAE-730493

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.

SAE

\*Exhaust manifold reactors, \*Thermal reactors, \*Manifold air injection systems, \*Exhaust emission control device tests, \*Exhaust emission measurement, \*Exhaust emission tests, \*Engine speeds, \*Air fuel ratio, \*Hydrocarbons, \*Carbon monoxide, \*Nitrogen oxides, \*Air pumps, \*Mathematical models,

The system involved throttling the inlet of the air pump (s) so that the air pump and engine intake pressures were equal. The continuous air modulation system was compared with an unmodulated system and a step-modulated system. The secondary air systems were investigated with both GMR small volume cast iron thermal reactors and Du Pont V thermal reactors on modified 350 CID V-8 engines in 1969 Chevrolet passenger vehicles. It was found that thermal reactor performance improved with each increase in control of the secondary air schedule. With the continuous air modulation system a reduction in CO emissions of approximately 45% (on the 1972 Federal Test Procedure emissions test) was achieved relative to an unmodulated system. None of the systems tested, however, demonstrated the capability to achieve 1975-1976 Federal ex-

HS-013 198

**MEASUREMENT OF AIR DISTRIBUTION IN A MULTICYLINDER ENGINE BY MEANS OF MASS FLOW PROBE**

General Motors Corp.

W. R. Brandstetter, M. J. Carr SAE 730494

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.

SAE

\*Air fuel ratio, \*Air flow rates, \*V 8 engines, \*Cylinders, \*Pressure transducers, \*Flowmeters, \*Unsteady state, \*Engine operating conditions, \*Thermocouples, \*Data reduction, \*Data processing,

A probe system was developed to measure mass flow rates to individual cylinders during engine operation. Fast response measurements of pressure, temperature, and flow velocity are made in the intake port near the valve during the intake portion of the cycle. Data collection was accomplished through use of an IBM 1800 computer. A V 8 engine with stock intake and single exhaust system was used in the initial application of the probe. Measurement of 30-40 individual cycles were combined to calculate the mean volumetric efficiency for each cylinder, and cylinder-to-cylinder distributions were computed as deviations from the overall average. Variations of plus/minus 8% were typical during motored operation, with some cylinders deviating by as much plus/minus 12%. Fired operation produced variations greater than plus/minus 15%. No characteristic distribution extended throughout the speed and load range tested. Typical cycle-to-cycle variations in the volumetric efficiency for individual cylinders were plus/minus 8%.

HS-013 199

**A SHORT COURSE ON CATALYSTS**

V8 N4 (Jul

R. M. Benrey

Search v8 n4 (Jul-Aug 1973)

\*Metallic catalysts, \*Oxidation catalysts, \*Pelleted catalysts, \*Reduction catalysts, \*Monolithic catalysts, \*Catalytic converters, \*Carbon monoxide, \*Hydrocarbons, \*Nitrogen oxides, \*Chemical reactions, \*Air fuel ratio, \*Platinum, \*Palladium, \*Particulate catalyst supports, \*Ruthenium,

Advantages and disadvantages of metallic, pellet, and monolithic catalysts are surveyed. The chemical reactions of oxidation and reduction are explained, noting that it is impossible for a single catalytic converter to speed up both kinds of reactions simultaneously and eliminate all three pollutants, carbon monoxide, hydrocarbon, and oxides of nitrogen, at once. Mechanical, thermal, and chemical problems affecting the durability of catalysts are reviewed.

HS-013 203

**THE UCLA HYDROGEN CAR: DESIGN, CONSTRUCTION, AND PERFORMANCE**

California Univ., Los Angeles

J. G. Finegold, F. E. Lynch, N. R. Baker, R. Takahashi, A. F. Bush SAE-730507

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.

\*Hydrogen fuels, \*Fuel 's systems, \*Automobile modification, \*Engine conversion, \*Flammability, \*Storage, \*Exhaust gas recirculation, \*Valve timing, \*Intake systems, \*Exhaust systems, \*Drivetrains, \*Energy absorbing bumpers, \*Automobile performance, \*Automobile handling, \*Crashworthy bodies, \*Passenger compartments, \*Exhaust emission tests, \*Oil seals, \*Piston rings, \*Cooling systems, \*Gremkins, \*Popcorn,

A 1972 Gremlin with a standard V 8 engine was modified to use hydrogen as a fuel. The problem of backfiring in hydrogen engines was solved by employing substantial exhaust gas recirculation. This vehicle meets the 1976 federal emissions standards. It has adequate power and interacts well in the urban environment. It would be economical to operate, and the engine should have a longer lifetime than gasoline engines. It has several novel safety features which could be incorporated into production vehicles: good evasive capabilities, an engine parameter monitoring system, a roll cage which lies outside the passenger compartment, and impact absorbing foam between inside and outside body panels for body stiffness and impact absorption. Bumpers containing popcorn absorb the energy of a 5 mph impact.

HS-013 208

## **COMPUTER SIMULATION OF THE UNIVERSITY OF WISCONSIN HYBRID-ELECTRIC VEHICLE CONCEPT**

Wisconsin Univ.

For primary bibliographic entry see Fld. 50.

HS-013 212

## **CONTRIBUTION OF THE VEHICLE POPULATION TO ATMOSPHERIC POLLUTION**

Automotive Environmental Systems, Inc.

C. E. Fegraus C. J. Domke J. Marzen SAE-730530

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.

SAE

\*Vehicle air pollution, \*Exhaust emission measurement, \*Exhaust emission sampling, \*Exhaust emission tests, \*Hydrocarbons, \*Carbon dioxide, \*Carbon monoxide, \*Nitrogen oxides, \*Vehicle weight, \*Engine size effect on exhaust emissions, \*Vehicle age, \*Date of manufacture, \*Automobile models, \*Test equipment, \*Chi square test, \*Statistical analysis Data processing,

Tests on 1,020 vehicles of the 1957-1971 model years to determine levels of hydrocarbons (HC), carbon monoxide (CO), carbon dioxide, and oxides of nitrogen (NOx) exhaust emissions were made in six cities. Vehicle exhaust emissions, as measured by the 1972 and 1975 Federal Test Procedure, were of similar magnitude among all cities except Denver. CO and HC effluents were significantly higher at higher altitude, but NOx were significantly lower. Emission results by manufacturer were relatively uniform. The 1968-1971 model year vehicles, which were subject to federal HC and CO exhaust controls, exhibited lower mean HC and CO levels than the 1957-1967 model year vehicles, although NOx levels were higher from the new, controlled vehicles.

HS-013 220

## **A LABORATORY FOR 1975-1976 VEHICLE EMISSION TESTING**

General Motors Corp.

A. Brown N. Brainard SAE-730531

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.

SAE

\*Exhaust emission tests, \*Exhaust emission control device tests, \*Laboratory tests, \*Data acquisition, \*Data reduction, \*Test facilities, \*Calibration, \*Servomechanisms, \*Computer printouts,

An exhaust emissions laboratory has been established where soak-and-test investigations can be performed in an integrated climate-controlled setting, in accordance with the 1975 Federal Test Procedure. Catalytic converter designs, catalyst materials, and other emissions-related engine and vehicle components are tested in this laboratory. The laboratory layout and capacity for making converter modal efficiency measurements is discussed. Data acquisition and reduction, facility calibration, real-data processing, and experience with a servo driver and with materials evaluation vehicles are described. Both an analog computer and a minicomputer are used in the laboratory, and a copy of a printout of a real-time modal data sheet, a test summary, and a data repeatability analysis are included.

HS-013 221

## **A SERVO VEHICLE DRIVER FOR EPA EMISSION TESTS**

General Motors Corp.

For primary bibliographic entry see Fld. 5D.

HS-013 222

## **VARIABLES FOR EMISSION TEST DATA ANALYSIS**

General Motors Corp.

W. H. Holl SAE-730533

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.

SAE

\*Exhaust emission tests, \*Data analysis, \*Exhaust emission measurement, \*Catalytic converters, \*Exhaust emission control device tests, \*Test reproducibility Data processing, \*Real time operations, \*Computer printouts, \*Exhaust gas flow patterns, \*Fuel economy, \*Fuel flow, \*Mathematical analysis, \*Gas analysis, \*Air fuel ratio, \*Equations, \*Oxygen, \*Fuel composition,

A comprehensive Environmental Protection Agency emission analysis program has been developed to determine the nature and relative significance of test variability and to provide consistent evaluation of the performance of catalytic converters. This includes real-time recordings of emission concentrations and mass rates, catalytic converter efficiencies, and air fuel ratio. Mass accumulations are printed out during the test at the end of each test mode. Test results and analysis of repeatability are summarized on-site immediately following the test. Simplified relationships between gas concentrations and engine variables have been developed.

HS-013 223

## **ASSURANCE AND CONTROL OF VEHICLE EMISSION TESTING**

General Motors Corp.

M. L. Moore SAE-730534

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.

SAE



## Group 5F—Fuel Systems

\*Exhaust emission tests, \*Catalyst tests, \*Exhaust emission control device tests, \*Test reproducibility, \*Computerized test methods, \*Computerized records management, \*Engine dynamometers, \*Data processing, \*Data analysis, \*Field tests, \*Catalytic converters, \*Exhaust emission measurement,

A three-point program is described which provides overall control of vehicle emission testing and assurance of acceptable product design. Experimental design techniques are used in the test development activities to control test parameters and to insure sufficient test repeatability for test evaluation. Test histories, established and automatically maintained on computer files, are continuously monitored to assure test control and to provide insights into the effects of various test parameters. The objectives of each specific test request are analyzed and experimental designs utilized to develop test plans and procedures. Illustrative examples in each area are included.

HS-013 224

#### BRAKE AND CLUTCH EMISSIONS GENERATED DURING VEHICLE OPERATION

Bendix Res. Labs.

M. G. JackoR. T. DuCharmeJ. H. Somers SAE-730548

Contract EPA-68-04-0020

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.

SAE

\*Brake emissions, \*Clutches, \*Disc brakes, \*Drum brakes, \*Asbestos, \*Emission tests, \*Friction, \*Instrumented vehicles, \*Particulate traps, \*Inertia dynamometers, \*Sampling, \*Electron microscopes, \*Brake temperature, \*Operating temperature, \*Brake lining wear, \*Friction materials, \*Particulate air pollutants, \*Clutch emissions,

Emissions collectors for disc and drum brakes were installed on a vehicle which was driven through various test cycles to determine the extent and type of brakes and clutch emissions generated at low- and high-operating temperatures. Brake emissions were removed from the collectors and mass balances were performed. The particulates were processed and analyzed optical and electron microscopy to ascertain the asbestos content and particle size distribution in the wear debris. Comparisons of emissions from new and used friction materials from disc and drum brakes and from original equipment and after-market materials were made. Finally, an estimate was made of the total asbestos emission by all of the vehicles in the country. On the average more than 99.7% of the asbestos is converted. The contribution to the atmosphere is 5060 lb or 3.2% of the total asbestos emission.

HS-013 231

#### AUTOMATED FUEL ROAD OCTANE RATINGS

American Oil Co.

B. D. KellerL. T. WrightI. GinsburghH. E. Rueckel SAE-730550

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.

SAE

An instrument has been developed for obtaining fuel antiknock ratings in cars by the modified borderline, the modified union-town, or the E-15 octane number requirement technique. It gives ratings that are more precise than those obtained conventionally, and the raters need not be so highly skilled. When combined with an automated driver, data logger, and fueling system, it permits up to 64 fuels to be road rated in triplicate at both full and part throttle by a single operator in an eight-hour shift. Reproducibility is about 0.7 octane for full throttle and 0.9 for part throttle, compared with about one and 1.5 octane, respectively, for conventional ratings.

HS-013 232

#### OPTIMUM OCTANE NUMBER FOR UNLEADED GASOLINE

American Oil Co. A36300

T. O. WagnerL. W. Russum SAE-730552

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.

SAE

\*Lead free gasoline, \*Octane requirements, \*Motor Octane number, \*Fuel costs, \*Gasoline mileage, \*Compression ratio, \*Engine performance, \*Regression analysis, \*Gasoline refining, \*Fuel economy,

Current evidence indicates that cars manufactured after 1974 or 1975 will be required to operate on unleaded gasoline. To determine the level of octane quality justified when refineries are producing only unleaded gasoline, improvements in mileage attainable by using gasoline of higher octane number were compared to costs of raising octane number. Motorists' total gasoline costs per mile are lowest when the octane number of the unleaded gasoline pool is in the range 85 to 87 Motor octane number. And, dividing the unleaded pool into at least two octane grades—one at one or two units above and one at two or three units below the pool value—maximizes car satisfaction for any given pool quality.

HS-013 234

#### DEVELOPMENT OF THE FEDERAL URBAN DRIVING SCHEDULE

Environmental Protection Agency

R. E. KruseT. A. Huls SAE-730553

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.

SAE

\*Urban areas, \*Exhaust emission measurement, \*Routes, \*Commuting patterns, \*Speed patterns, \*Driving conditions, \*Dynamometers, \*Federal role, \*Urban traffic flow,

The development of the LA 4 road route and efforts directed toward development of short repetitive dynamometer cycle based upon the road route are discussed. The instrumentation, methods, and selection process used to obtain a speed profile of a typical drive over the 12 mile long route are described. The methods used to shorten the speed profile to 7.5 miles and to shorten the average trip length, while preserving trip descrip-

October 17, 1973

VEHICLE SAFETY—Field 5

Fuel Systems—Group 5F

separated by idle periods of 0-39 seconds duration. The schedule covers 7.46 miles in 1372 seconds for an average speed of 19.6 mph.  
HS-013 235

## EVOLUTION OF FEDERAL LIGHT-DUTY MASS EMISSION REGULATIONS

Environmental Protection Agency

T. A. Huls SAE-730554

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Exhaust emission standards, \*Federal laws, \*State laws, \*Exhaust emission measurement, \*Exhaust emission tests, \*Fleets, \*Hydrocarbons, \*Carbon monoxide, \*Least squares method, \*Vehicle weight, \*Nitrogen oxides, \*Coldstarts, \*Hotstarts, \*Automobile models, \*Vehicle age, \*California,

The development of mass emission testing and the establishment of emission baselines and standards are presented. Tests were run on 30 precontrol, 138 1970, and 245 1971 light-duty vehicles to establish equivalency factors between average exhaust emissions when testing according to the 1970 (7-mode), 1972 (CVS-C), and the 1975 (CVS-CH) federal test procedures. The results were used to establish the 1972, 1973-1974, 1975, and 1976 standard values for hydrocarbon, carbon monoxide, and nitrogen oxide emissions.  
HS-013 236

## NEW INVESTIGATIONS OF EXHAUST GAS EMISSIONS OF MOTOR VEHICLE TRAFFIC

Trier-Kaiserlautern Univ. (West Germany)

H. MayW. MullerE. PlassmannF. J. Dreyhaupt SAE-730555

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Vehicle air pollution, \*Air pollution emission factors, \*Exhaust emission measurement, \*Forecasting, \*Cologne, \*Traffic density, \*Driving conditions, \*Traffic simulation, \*Hydrocarbons, \*Carbon monoxide, \*Nitric oxide, \*Otto cycle engines, \*Diesel engine exhaust emissions, \*Velocity, \*Traffic counts, \*Fuel consumption, \*Lead, \*Sulfur dioxide, \*Traffic characteristics, \*Day of week,

In the scope of efforts at air purification, a registration system has been developed on behalf of the Ministry of Labor, Health, and Social Affairs of North-Rhine-Westphalia considering every kind of emission contributing to air pollution. The system for the registration of vehicle emissions and the first results for the area of Cologne are discussed in this paper. The specific emission factors for Otto and diesel engine equipped cars depending upon the mean driving velocity are given. These values can be considered as representative for the Federal Republic of Germany for passenger cars due to the great number of tested vehicles. The emission factors of diesel engine powered vehicles, however, are only valid for rough estimations with regard to the local exhaust emission. For detailed investigation in

## INFLUENCE OF VEHICLE DRIVING PATTERNS ON LOCALIZED URBAN EMISSIONS SOURCES

Imperial Coll. of Science and Technology (England)I18600

H. C. Watson SAE-730556

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Vehicle air pollution, \*Mathematical models, \*Exhaust emission measurement, \*Driving style effect on exhaust emissions, \*Air pollution control, \*Forecasting, \*Spark ignition engines, \*Diesel engine exhaust emissions, \*Model tests, \*Air fuel ratio, \*Traffic flow, \*Air pollution emission factors, \*Urban areas, \*Speed, \*Traffic models, \*Acceleration, \*Deceleration, \*Idling, \*Cruising, \*Carbon monoxide, \*Hydrocarbons, \*Nitrogen oxides, \*European vehicles, \*Edinburgh, \*Air flow rates, \*Fuel flow,

Procedures for calculating the emissions of the population average diesel and gasoline fueled vehicles in a range of operating modes are presented. These procedures, together with a simple, but flexible, model of vehicle driving patterns, are used to show how changes in traffic flow and driving patterns can influence the vehicular source of emissions along urban roadways. The procedures are applied to predict emission rates in hypothetical traffic flows and in real traffic conditions as measured in central Edinburgh, Scotland, where the relative contributions of individual traffic groups to the vehicular emission sources have been assessed.  
HS-013 238

## AN ENGINE DYNAMOMETER SYSTEM FOR THE MEASUREMENT OF CONVERTER PERFORMANCE

General Motors Corp.

D. M. HerodM. V. NelsonW. M. Wang SAE-730557

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Engine dynamometers, \*Catalytic converters, \*Exhaust emission control device tests, \*Test facilities, \*Performance tests, \*Exhaust emission sampling, \*Gas analysis, \*Exhaust gases, \*Test reproducibility, \*Gas analyzers, \*Data reduction, \*Forecasting, \*Performance characteristics, \*Mathematical models, \*Exhaust emission tests, \*Exhaust emission measurement,

An engine dynamometer converter performance test which embodies the measurement of transient conversion efficiency when a converter is subjected to a step input of a steady-rate exhaust gas has been developed. The test facility consisting of a dynamometer controlled engine, converter flow control system, emission analyzers, and computer interface has been found to offer repeatable measurement of converter performance and effective testing efficiency. Predicted Environmental Protection Agency (EPA) run performance has been successfully correlated with actual Vehicle EPA Test results. The mathematical model for generating the predicted normalized EPA results is presented.  
HS-013 239

General Motors Corp.  
J. P. Casassa D. G. Beyerlein SAE-730558  
Presented at Automobile Engineering Meeting, Detroit, 14-18  
May 1973.  
SAE

\*Catalytic converters, \*Durability tests, \*Engine dynamometers, \*Catalyst poisoning, \*Servomechanisms, \*Exhaust emission tests, \*Carbon monoxide, \*Hydrocarbons, \*Sulfur, \*Stability, \*Deposition Laboratory tests, \*Simulation, \*Catalyst tests,

Three dynamometer testing schedules are described which are used to screen (rank) catalysts; to show how well a given catalyst preparation can be expected to perform after being given significant distance; and to study catalyst poisoning, particularly sulfur poisoning. The schedules include a federal driving schedule, a simulated federal schedule, and a catalyst stability evaluation schedule. When there is a marked difference in hydrocarbon results due to differences in lead concentrations in the fuel. Catalyst stability test results correlate well with vehicle test results.

HS-013 240

## CYCLE SIMULATION

Corning Glass Works  
E. H. Comfort J. S. Howitt J. W. MacBeth SAE-730559  
Presented at Automobile Engineering Meeting, Detroit, 14-18  
May 1973.  
SAE

\*Catalytic converters, \*Exhaust emission control device tests, \*Mathematical models, \*Simulation, \*Exhaust emission tests, \*Exhaust emission measurement, \*Performance tests, \*Exhaust emission sampling, \*Carbon monoxide, \*Hydrocarbons, \*Linear regression analysis, \*Engine dynamometers, \*Computerized simulation, \*Oxidation, \*Engine operating conditions, \*Exhaust gases, \*Test equipment, \*Steady state, \*Correlation analysis, \*Forecasting.

The theoretical and experimental considerations and mathematical model results used to establish a simplified engine dynamometer test for catalytic converters are discussed. Simulation results have been correlated with the Environmental Protection Agency (EPA) Federal Test Procedure (CVS-I) parameters. Working curves are presented to allow the user to predict ultimate catalytic converter performance in grams/mile. Statistical correlation coefficients show predicted values and actual CVS-I values to be highly correlated. A linear regression analysis demonstrates that the cycle simulation procedure described provides an excellent one-to-one guide to EPA Federal Test results.

HS-013 241

## EFFECT OF ALTITUDE ON OCTANE REQUIREMENT--1972 CARS

Gulf Res. and Devel. Co.  
Jr., H. A. Bigley B. D. Keiler T. Wusz SAE-730551  
Presented at Automobile Engineering Meeting, Detroit, 14-18  
May 1973. Based on Effect of Altitude Changes on Octane Number Requirements of Late Model Cars, " Coordinating Res. Council Report.

SAE

\*Altitude, \*Octane requirements, \*Engine tests, \*Knock, \*Road octane number, \*Vehicle age, \*Test facilities, \*Test

reproducibility, \*Air fuel ratio, \*Barometric pressure, \*Fuel quality, \*Humidity, \*Temperature,

A program was conducted during the summer of 1972 to determine the decrease in octane number requirement with altitude for current model cars because the engines in these cars run hotter and leaner than earlier models, no information was available on altitude corrections for unleaded fuels, and no adjustment was planned for the American Society for Testing Materials/SAE. Maximum octane number requirements were determined on 39 1971-1972 model cars, six 1967-1970 model cars, and four light-military trucks at sea level, 2000, and 4000 feet on three series of full-boiling range and primary reference fuels. The decrease in octane number requirement per inch of mercury decrease (approximately per 1000 feet) is about two units for 1971-1972 cars and 1.5 units for the 1967-1970 cars and the four military trucks.

HS-013 333

## 5N. Occupant Protection

### EVALUATE AIRBAG RESTRAINTS FOR SUBCOMPACT CAR PASSENGERS. VOL. 2. FINAL PROGRAM REPORT

Southwest Res. Inst.  
J. D. Michie M. E. Bronstad SWRI-03-3142-2  
Report for 29 Jun 1971-13 Nov 1972. Vol 1 is HS-800 831.  
NTIS

\*Air bag restraint systems, \*Restraint system effectiveness, \*Restraint system tests, \*Occupant protection, \*Front seat passengers, \*Compact automobiles, \*Impact sleds, \*Barrier collision tests, \*Anthropometric dummies, \*Ford Pinto, \*Angle impact tests, \*Acceleration response, \*Deceleration, \*Occupant kinematics, \*Occupant kinetics, \*Knee restraints, \*Chest acceleration tolerances, \*Injury severity index, \*Air bag inflation pressure, \*High speed photography, \*Femurs, \*Loads (forces), \*Performance characteristics,

An experimental program was conducted to gather data on the performance of two currently available air bag restraint systems for front seat passengers of subcompact cars. Twenty sled tests and four full-scale crashes were conducted using various arrangements of anthropometric dummies. Both the vehicles and the dummies were instrumented and high speed movies were taken. Evaluation of air bag restraint systems was made. The program demonstrated that the Olin Corporation airbag restraint system offers adequate protection for a 95th percentile male passenger of a subcompact class vehicle during a normal 30 mph frontal rigid barrier impact and for a 50th percentile male passenger during a 30 right oblique 30 mph rigid barrier impact. However, these findings pertain to the 1971-72 Ford Pinto and are not necessarily applicable to other subcompact cars.

HS-800 832

### EVALUATE AIRBAG RESTRAINTS FOR SUBCOMPACT CAR DRIVERS. VOL.2, FINAL PROGRAM REPORT

Southwest Res. Inst.  
J. D. Michie M. E. Bronstad SWRI-03-3143-2  
Contract DOT-HS-024-1-164  
Report for 29 Jun 1971-13 Nov 1972. Vol 1 is HS-800 833  
NTIS

system tests, \*Restraint system effectiveness, \*Barrier collision tests, \*Anthropometric dummies, \*Instrumented vehicles, \*Ford Pinto, \*Impact sleds, \*Deceleration, \*Impact angle, \*Impact velocity, \*Occupant kinematics, \*Air bag inflation pressure, \*Acceleration response, \*Human acceleration tolerances, \*Energy absorbing steering columns, \*Body design, \*Passenger compartments, \*Photographs, \*Angle impact tests, \*Injury prevention, \*Test equipment,

Twenty sled tests and four full-scale barrier collision tests using Ford Pintos were conducted. Both the vehicles and the anthropometric dummies used were instrumented and high speed movies were taken. Test results indicate that the air bag restraint system protects the 50th percentile male driver of a subcompact vehicle from serious injury during a normal 30 mph frontal rigid barrier impact. Data from a 95th percentile male dummy driver indicate that severe chest injuries can be expected for the 60 mph rigid barrier test with the vehicle approaching the barrier at 30 clockwise from normal if the steering column mounting is not redesigned. The Pinto demonstrated structural crashworthiness for normal and 30 oblique frontal barrier impact for speed slightly above 30 mph. The collapsible steering column failed to properly deform in all vehicle crash tests, possibly due to nonsymmetrical loading.  
HS-800 834

#### **ALTERNATE PASSIVE OCCUPANT RESTRAINT DEVELOPMENT. FINAL REPORT**

Beta Industries, Inc.  
N. S. Phillips B11-227-1  
Contract DOT-HS-220-2-375  
Report for 5 May 1972-31 Jan 1973.  
NTIS

\*Passive restraint systems, \*Restraint system effectiveness, \*Restraint system tests, \*Occupant protection, \*Restraint system design, \*Automatic seat belts, \*Shielding, \*Net restraint systems. Cushioning, \*Barriers, \*Integrated seats, \*Blanket restraint systems, \*Inflatable structures, \*Injury prevention, \*Injury severity index, \*Computerized simulation, \*Simulation models, \*Data acquisition, \*Data processing, \*Acceleration response, \*Human acceleration tolerances, \*Degrees of freedom, \*Surveys,

A survey of patents, literature, and manufacturers provided fifty passive restraint devices which were classified into seven categories: shields, nets, cushions, arms and barriers, seat belts, integrated seats, and blankets. These were examined in a preliminary analysis to select the concepts having the greatest potential to equal or exceed the life-saving potential of the inflatable restraint system. Two systems were selected based on loading patterns, practicality, and user acceptance, and analyses were conducted using the Highway Safety Research Institute three degrees of freedom model. Measured test data for a previously conducted inflatable study were used as input into the program. A 25 G half-sine pulse of 30 mph velocity change created an intolerable response for a 50th percentile dummy contained in a barrier seat concept, but acceptable response for a passive seat belt concept at 30 and 40 mph velocity change. A passive seat belt system was the best device uncovered.  
HS-800 858

#### **STRUCTURAL MODIFICATIONS TO SUBCOMPACT CARS FOR FRONTAL IMPACTS. INTERIM TECHNICAL REPORT**

Calspan Corp.  
For primary bibliographic entry see Fld. 5D.  
HS-800 864

#### **THE EFFECT OF VEHICLE STRUCTURE CHARACTERISTICS ON OCCUPANT RESTRAINT PARAMETERS. A PARAMETRIC STUDY. TECHNICAL REPORT**

National Hwy. Traf. Safety Administration  
R. A. Krauss C. E. Strother  
Report for Nov 1972-Mar 1973.  
NTIS

\*Restraint system effectiveness, \*Simulation models, \*Computerized simulation, \*Body design, \*Computer programs, \*Deceleration, \*Passenger compartments, \*Crashworthiness, \*Fortran, \*Flow charts, \*Impact velocity, \*Crush distance, \*Deformation, \*Time factors, \*Equations of motion, \*Accident simulation,

A simple, one-dimensional model was constructed of the crash of a vehicle and restrained occupant for the purposes of better understanding the relationship between the response of the vehicle structure and the restraint system. The equations of motion of this model were derived and a computer program written to produce both printed and graphical solutions to these equations. The model and computer program are included and the results analyzed.  
HS-820 260

#### **50. Propulsion Systems**

#### **COMPUTER SIMULATION OF THE UNIVERSITY OF WISCONSIN HYBRID-ELECTRIC VEHICLE CONCEPT**

Wisconsin Univ.  
J. R. Winkelman A. A. Frank SAE-730511  
Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Electric vehicles, \*Urban automobiles, \*Hybrid vehicles, \*Computerized simulation, \*Power trains, \*Fuel economy, \*Internal combustion engines, \*Lead acid batteries, \*Battery packs, \*Battery charging, \*Vehicle performance,

The design and simulation of the urban vehicle power train system of the University of Wisconsin are described. Fuel efficiency is achieved by an on-off operation of the internal combustion engine with the on operation at only the minimum brake specific fuel consumption area. Emission control is partially achieved by utilizing an electric drive system for transient response. Low emissions and fuel efficiency are bettered by techniques such as special starting without choke, no deceleration, and no idle requirements on the internal combustion engine. The vehicle has three operating modes: an all electric mode; a hybrid mode in which a fraction of the internal combustion engine power is used to propel the car and the remainder to drive the generator and recharge the batteries; and

**Group 50—Propulsion Systems**

the parallel mode in which total internal combustion engine power is available for propelling the car, and electric power can be added as needed.

HS-013 212

**5Q. Safety Defect Control****1971 ANALYSIS OF MOTOR CARRIER ACCIDENTS INVOLVING VEHICLE DEFECTS OR MECHANICAL FAILURE**

Bureau of Motor Carrier Safety

For primary bibliographic entry see Fld. 1C.

HS-013 179

**MOTOR VEHICLE SAFETY DEFECT RECALL CAMPAIGNS REPORTED TO THE NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION BY DOMESTIC AND FOREIGN VEHICLE MANUFACTURERS, JANUARY 1, 1973 TO MARCH 31, 1973**

National Hwy. Traf. Safety Administration

GPO

\*Recall campaigns, \*Automobile recall campaigns, \*Truck recall campaigns, \*Trailer recall campaigns, \*Tire recall campaigns, \*Child safety seats, \*Suspension systems, \*Defect correction, \*Hubs, \*Statistics, \*Defective vehicles, \*Defective tires, \*Defects, \*Foreign vehicles, \*Defects, \*Foreign vehicles,

This tabulation of safety defect recall campaigns includes the make and model, model year, description of the defect requiring manufacturer's corrective action, number of vehicles recalled, date of notification, and identification number. Automobiles, trucks, trailers, buses, tires, child safety seats, suspension systems, and hub and stud assemblies are included.

HS-820 268

**5R. Steering Control Systems****SIMULATION AND MEASUREMENT OF DRIVER VEHICLE HANDLING PERFORMANCE**

Volkswagenwerk A.G. (West Germany)

For primary bibliographic entry see Fld. 3D.

HS-013 195

**DEVELOPMENT OF MOTOR VEHICLE HANDLING PERFORMANCE REQUIREMENTS**

National Hwy. Traf. Safety Administration

R. Limpert SAE-730490

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.

SAE

\*Vehicle handling, \*Driver skills, \*Compliance tests, \*Driver vehicle interface, \*Accident prevention,

Specific problems relating to the vehicle, the driver, and the environment are highlighted. Research activities performed and anticipated both in the U.S. and in Europe are discussed.

of these investigations is to identify those vehicles that become overinvolved in highway accidents and, together with other vehicles exhibit performance boundaries which are beyond the capabilities of the typical driver.

HS-013 196

**REFINEMENT AND APPLICATION OF OPEN-LOOP LIMIT-MANEUVER RESPONSE METHODS**

Michigan Univ. Hwy. Safety Res. Inst.

R. D. Ervin P. S. Fancher L. Segel SAE-730491

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.

SAE

\*Automobile handling, \*Automobile performance, \*Braking, \*Sideslip, \*Vehicle stability, \*Data processing, \*Performance tests, \*Steering, \*Test equipment, \*Fifth wheel devices, \*Automatic control, \*Roll,

Refinements in methodology were attained in the areas of test apparatus, test procedure, data processing, and performance interpretation. Open-loop response measurements were conducted on a representative sample of 12 contemporary passenger vehicles. Numeric characterizations of performance are presented, indicating the range and distribution of response properties exhibited by the vehicle sample.

HS-013 197

**EVALUATION OF VEHICLE HANDLING AND STABILITY BY COMPUTER SIMULATION AT THE FIRST STAGE OF VEHICLE PLANNING**

Toyo Kogyo Co. Ltd. (Japan)

T. Okada T. Takiguchi M. Nishioka G. Utsunomiya SAE-730525

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.

SAE

\*Vehicle handling, \*Vehicle stability, \*Computerized simulation, \*Mathematical models, \*Degrees of freedom, \*Tire characteristics, \*Least squares method, \*Steering, \*Turning radius, \*Aerodynamics, \*Roll, \*Yaw, \*Pitch, \*Equations of motion, \*Lateral acceleration, \*Understeer, \*Oversteer, \*Sideslip, \*Parameters, \*Flow charts, \*Turning,

Computer simulation of three vehicle motions has been made possible over a range up to high lateral acceleration. These three motions are stationary circular turning motion, slalom motion, and straight-running motion (against disturbances) selected as fundamental motions for evaluating vehicle handling and stability. The mathematical model is a nonlinear one with seven degrees of freedom and 63 design parameters. The validity of this model has been confirmed experimentally. As for slalom motion, critical slalom speed with pole interval used as a parameter has been obtained theoretically. In the process, some of the slalom characteristics that are known experimentally and empirically have been substantiated by assuming driver's perception and physical limits relative to steering.

HS-013 215

**A COMPUTER SIMULATION FOR THREE-DIMENSIONAL VEHICLE DYNAMICS**

Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Vehicle dynamics, \*Computerized simulation, \*Vehicle handling, \*Suspension systems, \*Vehicle mass, \*Roll, \*Angular velocity, \*Aerodynamics, \*Tire characteristics, \*Tire side forces, \*Lateral acceleration, \*Yaw, \*Mathematical models, \*Degrees of freedom, \*Equations of motion, \*Flow charts, \*Steering systems, \*Turning,

A 14 degrees of freedom mathematical model that was developed to analyze and predict the handling dynamics of a four-wheel vehicle is described. The system of nonlinear equations was programmed and numerically solved on the digital computer where the inputs are Ackerman steer angle to front and/or rear wheels and driving or braking torques on any or all wheels. The equations of motion for the sprung and unsprung masses were derived using Lagrange's equation. Constraints were included in the equations, which forced the sprung mass to roll about an inclined center roll axis. The analysis also included nonlinear tire characteristics as well as suspension geometry and compliance parameters, such as roll steer, roll camber, auxiliary roll stiffness, and lateral force deflection steer. The results of computer simulations for J-turn maneuvers are compared with experimentally measured data for two different speeds and steering inputs.  
HS-013 216

## 5T. Trucks And Trailers

### COMPUTER SIMULATION OF THE BRAKING AND HANDLING PERFORMANCE OF TRUCKS AND TRACTOR-TRAILERS

V3 N5  
P. S. Fancher C. B. Winkler J. E. Bernard  
Sponsored by the Motor Vehicle Manufacturers Assoc.  
HIT LAB Reports v3 n5 pl-7 (Jan 1973)

\*Truck brakes, \*Trailer brakes, \*Truck handling, \*Truck performance, \*Braking distance, \*Suspension systems, \*Air brakes, \*Laboratory tests, \*Computerized simulation, \*Tractor trailers, \*Articulated vehicle modeling, \*Articulated vehicle performance, \*Performance tests, \*Brake performance,

Subjects discussed are heavy-vehicle suspension dynamics, air-brake system operation, laboratory measurements of vehicle components, vehicle performance tests, and simulation validation. Comparisons, showing a high degree of correlation between vehicle test data and simulation results, are presented for straight-line-braking and braking-in-a-turn maneuvers.  
HS-013 175

### 1971 ANALYSIS OF MOTOR CARRIER ACCIDENTS INVOLVING VEHICLE DEFECTS OR MECHANICAL FAILURE

Bureau of Motor Carrier Safety  
For primary bibliographic entry see Fld. 1C.  
HS-013 179

### MOTOR CARRIER ACCIDENT INVESTIGATION. ILLINOIS-CALIFORNIA EXPRESS, INC. ACCIDENT--JULY 24, 1972--PHOENIX ARIZONA

Bureau of Motor Carrier Safety  
For primary bibliographic entry see Fld. 1C.  
HS-013 180

**MOTOR CARRIER ACCIDENT INVESTIGATION. TOMMIE C. KINARD AND LARRY L. RAMSEY AND METROPOLITAN FUELS CO., INC. ACCIDENT--APRIL 13, 1972--NEAR MERRIFIELD, VIRGINIA**  
Bureau of Motor Carrier Safety  
For primary bibliographic entry see Fld. 1C.  
HS-013 181

## 5V. Wheel Systems

### THE CHALLENGE OF DEVELOPING PERFORMANCE TESTS RELATED TO CONSUMER NEEDS

National Hwy. Traf. Safety Administration  
F. C. Brenner  
1973 PJ/1-J/5 engineering Conference (3 rd),

\*Performance tests, \*Tire tests, \*Research methods,

The process of developing performance tests consists of the establishment of performance requirements, criteria evaluation, and specifications. The process is illustrated using the development of tire performance tests as an example. Pitfalls in developing and applying a test are described. The differences that distinguish performance tests for the ultimate consumer from other standard tests are examined. It is concluded that performance tests to evaluate consumer products would be more successful if the tests simulate the service conditions in an obviously analogous manner, requiring a minimum of intellectual interpretation. Also, levels distinguishing quality differences should be far enough apart to be clearly discernible but not distant enough to lose real quality differences.  
HS-013 177

### WHAT MAKES A GOOD RADIAL TIRE?

V81 N6  
K. G. Peterson R. E. Rasmussen  
Based on SAE-730500, Mechanical Properties of Radial Tires.  
Automotive Engineering v81 n6 p52-6 (June 1973)

\*Radial tires, \*Tire properties, \*Tire performance, \*Tire riding characteristics, \*Tire traction, \*Tire sizes, \*Steel belted tires, \*Tire forces, \*Tire moments, \*Tire rolling resistance, \*Bias belted tires, \*Tire noise, \*Tire spring rates, \*Vehicle handling,

Dimensions, handling, ride, traction, noise, and power loss of steel-belted radial tires are discussed and compared with bias belted tires. Possible effects of radial tires on vehicle handling are: reduction of understeer, increased steering sensitivity, increased response time and wind disturbance sensitivity, reduced road feel, and decreased sensitivity to service factors such as load and inflation pressure.  
HS-013 185

### WIRE TIRE CORD-CONSTRUCTION REQUIREMENTS

Firestone Tire and Rubber Co.  
P. F. Murray SAE-730497  
Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.  
SAE

\*Tire cords, \*Wire, \*Tire design, \*Tire materials, \*Mechanical Properties,



HS-013 225	5A	HS-013 228	5V
HS-013 226	5A	SAE-730540	5D
HS-013 227	5V	HS-013 229	5D
HS-013 228	5V	SAE-730547	5D
HS-013 229	5D	HS-013 230	5F
HS-013 230	5D	SAE-730548	5F
HS-013 231	5F	HS-013 231	5F
HS-013 232	5F	SAE-730550	5F
HS-013 233	5F	HS-013 232	5F
HS-013 234	5F	SAE-730551	5F
HS-013 235	5F	HS-013 333	5F
HS-013 236	5F	SAE-730552	5F
HS-013 237	5F	HS-013 234	5F
HS-013 238	5F	SAE-730553	5F
HS-013 239	5F	HS-013 235	5F
HS-013 240	5F	SAE-730554	5F
HS-013 241	5A	HS-013 236	5F
HS-013 242	5A	SAE-730555	5F
HS-013 243	5F	HS-013 237	5F
HS-013 244	5F	SAE-730556	5F
HS-013 245	5N	HS-013 238	5F
HS-013 246	5N	SAE-730557	5F
HS-013 247	5D	HS-013 239	5F
HS-013 248	5D	SAE-730558	5F
HS-013 249	5N	HS-013 240	5F
HS-013 250	5D	SAE-730559	5F
HS-013 251	5D	HS-013 241	5F
HS-013 252	5F	SAE-730562	5A
HS-013 253	5D	HS-013 242	5A
HS-013 254	5D	SAE-730563	5A
HS-013 255	5D	SEA-730509	5D
HS-013 256	5D	HS-013 210	5N
HS-013 257	3I	SMRI-03-3142-2	5N
HS-013 258	3I	HS-800 832	5N
HS-013 259	5D	SMRI-03-3143-2	5N
HS-013 260	5D	HS-800 834	1C
HS-013 261	5D	TRRL-LR-551	5F
HS-013 262	5D	UCRL-5122A	5D
HS-013 263	5D	HS-013 173	5D
HS-013 264	5F	Y8-2987-V-10	5D
HS-013 265	5F	HS-800 864	5D
HS-013 266	5F	Y8-2987-V-5	5D
HS-013 267	5F	HS-800 865	1C
HS-013 268	3D	72-7	1C
HS-013 269	3D	HS-013 181	1C
HS-013 270	3D	72-8	1C
HS-013 271	3D	HS-013 180	1C



## **CONTRACT AWARD INDEX**



#### **DOT-HS-359-3-733**

##### **PROTOTYPE DRIVER PERFORMANCE MEASUREMENT AND ANALYSIS SYSTEM (DPMAS)**

Systems Technology, Inc.  
13766 South Hawthorne Boulevard  
Hawthorne, California 90250

30 June 73 to 28 June 74

\$282,987

A system will be developed to measure driver skills and judgement under both experimental range and actual roadway conditions. Characteristics of the driver, vehicle, and environment will be established, and a prototype driver performance measurement and analysis system assembled. Development of the required software packages will be initiated.

#### **DOT-HS-359-3-762**

##### **DRIVER-VEHICLE RESPONSE RESEARCH**

Systems Technology, Inc.  
13766 South Hawthorne Boulevard  
Hawthorne, California 90250

30 June 73 to 28 June 74

\$464,426

Research will be done to determine how the response of a vehicle to a driver's steering input affects the driver's ability to maintain precise control over the vehicle path in both normal and emergency maneuvers. Optimum system and subsystem characteristics will be identified. Other requirements are to demonstrate that the experimental results obtained in the research are applicable to current production vehicles; to correlate objective parameter measurements with subjective driver evaluation; and to correlate optimum driver/vehicle response characteristics with open-loop tests for possible compliance tests.

#### **DOT-HS-053-3-727**

##### **RESEARCH ON THE EFFECTS OF TIRE PROPERTIES ON VEHICLE HANDLING**

Calspan Corporation  
4455 Genesee Street  
Buffalo, New York 14221

30 June 73 to 29 June 74

\$283,810

A study will be made to identify the properties of tires

those effects in quantitative terms. An evaluation will be made of the degree to which the various tire parameters affect vehicle dynamic response, and their relative importance assessed. A plan of work and methodology will be developed, literature surveyed, tire parameters selected, vehicles obtained, and full-scale tests conducted.

#### **DOT-HS-355-3-718**

##### **CAUSATIVE FACTORS AND COUNTERMEASURES FOR RURAL PEDESTRIAN ACCIDENTS**

Biotechnology, Inc.  
3027 Rosemary Lane  
Falls Church, Virginia 22042

30 June 73 to 31 Aug 76

\$393,068

A study will be made to develop data collection rationales, models, and techniques needed to investigate an adequate sample of rural pedestrian accidents for analysis. These data will be used to identify the causal factors of rural pedestrian accidents; to identify countermeasures relevant to the identified types; and to evaluate countermeasures by means of a behavioral evaluation of pedestrians and traffic.

#### **DOT-HS-031-3-676**

##### **TIRE SHEAR FORCE EVALUATION**

The Regents of the University of Michigan  
240 Research Administration Building  
Ann Arbor, Michigan

25 June 73 to

\$15,216

A study will be made to determine the influence of wheel deceleration rate on braking force, and to determine a methodology for obtaining side force numerics by examining existing lateral tire force data. Literature will be examined for information on the influence of wheel deceleration on longitudinal force. The influence of wheel deceleration on longitudinal force will be measured for a sample of tires specified by SSL, and currently available lateral tire force data will be studied to perfect data analysis techniques to obtain a numeric for side force while minimizing the number of test conditions, vehicle size, and load.

**DOT-HS-334-3-645**

**DEVELOPMENT OF COURSE AND MATERIALS FOR  
TRAINING IN DWI LAW ENFORCEMENT: DETEC-  
TION, APPREHENSION, AND TESTIMONY**

Michigan State University  
East Lansing, Michigan 48823

30 June 73 to

\$149,888

**DOT-HS-213-3-695**

**APL/JHU HYBRID VEHICLE HANDLING PROGRAM**

Department of the Navy  
Naval Ordnance Systems Command  
Washington, D.C.

\$

Action will be taken to refine and update the APL/  
JHU Hybrid Vehicle Handling Program (HVHP).  
The HVHP will be refined to increase operating ef-  
ficiency and reduce running time. Objectives are to  
improve operating efficiency, improve ease of use, and  
to test and verify various procedures.

**DOT-HS-053-3-609**

**A TRI-LEVEL STUDY OF THE CAUSES OF INJURY  
IN TRAFFIC ACCIDENTS**

Calspan Corporation  
4455 Genesee Street  
Buffalo, New York 14221

1 Jan 73 to 31 Mar 1974

\$285,000

A tri-level accident study will be conducted in an eight-  
county area of western New York to establish a base  
line of driver, vehicle, and highway accident exposure  
and gross accident experience in the defined area;  
detailed accident data will be collected on selected  
vehicles; the occupant injury cause and severity will  
be determined, as well as the accident type and  
severity. The project will be conducted on three  
distinctly defined levels. Resulting data are analyzed  
to develop material describing causal information.

**DOT-HS-053-3-619**

**TRI-LEVEL STUDY COLLISION DATA ANALYSIS**

Calspan Corporation  
4455 Genesee Street  
Buffalo, New York 14221

1 Jan 73 to 31 Mar 74

\$120,629

A previously performed tri-level study and other  
sources will be analyzed to prepare six specific  
studies. The first study will analyze current statistics  
and trends to facilitate comparisons of vehicle types  
and model years, and driver groups and accident  
classes. The second study will improve the use and  
interpretation of data through better methods for  
analysis, and will obtain more factual information  
through certain comparisons. The third study will  
estimate the risk of total and partial ejection through  
side glass, backlight, windshield, and door. The  
fourth study will examine the injury risk associated  
with passenger compartment intrusion. The fifth  
study will apply methodology from Calspan report No.  
ZM-5010-V-3 to determine accident causes through  
specified procedures. The sixth study will provide  
information concerning the shift in injury potential  
associated with individual vehicle components.

**DOT-HS-323-3-622**

**DOCUMENTATION FOR ALDERSON TEST DUMMY**

Alderson Research Laboratories, Inc.  
390 Ludlow Street  
Stamford, Connecticut 06904

15 Feb 73 to 11 June 73

\$2,910

Furnishes the design, data, drawing, and documenta-  
tion package for the Alderson VIP-50A Test Dummy.

**DOT-HS-008-3-624**

**DOCUMENTATION FOR SIERRA TEST DUMMY**

Sierra Engineering Company  
123 East Montecito Avenue  
Sierra Madre, California 91024

15 Feb 73 to 1 May 73

\$9,300

Furnishes the design, data, drawing, and documenta-  
tion package for the Sierra 50th Percentile Hybrid II  
Test Dummy.

**DOT-HS-001-3-572**

**RETREADED PASSENGER CAR TIRE ROAD AND  
LABORATORY CORRELATION—ENDURANCE TESTS**

Automotive Research Associates, Inc.  
5404 Bandera Road  
San Antonio, Texas 78238

Six months from receipt of Government-furnished tires.

\$6,446

This modification provides for sixty additional tire road and laboratory correlation endurance tests to support rulemaking activities related to endurance testing on laboratory dynamometers, and road test data to correlate the failure mode experienced by the consumer.

**DOT-HS-024-3-659**

**LABORATORY TESTING PROCEDURES**

Southwest Research Institute  
8500 Culebra Road  
San Antonio, Texas 78228

11 April 73 to 10 May 73

\$25,395

Laboratory procedures will be developed to test passenger vehicles for FMVSS No. 216, FMVSS No. 214, FMVSS No.s 208, 212, and 301; to test passenger vehicles to all requirements of FMVSS No. 215; and to test buses having GVWR of at least 10,000 pounds for FMVSS No. 217.

**DOT-HS-005-3-657**

**ACCELERATOR CONTROL SYSTEMS TEST**

Dayton T. Brown, Inc.  
Church Street  
Bohemia, Suffolk County, New York 11716

12 April 73 to 12 June 73

\$9,300

Specified vehicles are used to determine the practicality of the compliance test procedure required by FMVSS No. 124 after the vehicles are modified with redundant throttle return springs to bring the mechanical configuration of the accelerator control system in conformance with FMVSS No. 124.

**DOT-HS-094-2-253**

**MOTOR VEHICLE INSPECTION EVALUATION  
PROJECT**

Ultrasystems, Incorporated  
500 Newport Center Drive  
Newport Beach, California 92660

21 April 73 to 1 Aug 73

\$56,969

This modification provides for the installation, verification, and demonstration of computer software developed under the original contract.

**DOT-HS-227-2-388**

**ALCOHOL COUNTERMEASURES PROGRAM**

Systems Technology, Inc.  
13766 Hawthorne Boulevard  
Hawthorne, California 90250

Extended to Sept 73

\$22,877

This modification provides for the addition of the number of subjects tested in each group, and the provision of an additional group to be tested.

**DOT-HS-211-3-677**

**STANDARD ACCIDENT FILE EXTRACT (SAFE)**

State of Maryland  
Dept. of Public Safety and Correctional Services  
P.O. Box 5743  
Pikesville, Maryland 21208

30 April 73 to 31 Mar 74

\$20,000

The State of Maryland Master Accident Data File for the calendar year 1973 will be brought to current status in order to provide NHTSA with statistical information and an expanded data base for research. The State of Maryland Master Accident File for 1973 will be coded, copied, and submitted on magnetic tapes.

**DOT-HS-137-3-648**

**TECHNICAL AND OPERATIONAL ASSISTANCE—  
FATALITY ANALYSIS FILE**

Genasys Corporation  
4853 Cordell Avenue  
Suite A10  
Bethesda, Maryland 20014

1 May 73 to 30 April 74

\$168,465

The purpose of this effort is to implement the establishment of a nationwide accident reporting system that will be established to link the accident, driver, vehicle, roadway, and contributing factors. Inputs from the States are controlled and various document control procedures are applied to ensure complete reporting from participating jurisdictions. Quality control will include manual edit to identify certain errors, and computer edits will be made to identify problems requiring resolution. FAF case records will be converted to a computer-acceptable medium. Data converted to magnetic tapes will be produced in accordance with Federal Highway Administration computer operating system level requirements.

**DOT-HS-046-3-667**

**PASSENGER CAR DIRECTIONAL CONTROL TEST**

Dynamic Science, Division of Ultrasonics, Inc.  
1850 West Pinnacle Peak Road  
Phoenix, Arizona 85027

1 May 73 to 31 Oct 73

\$68,643

The stopping capability of passenger cars will be determined during steering maneuver utilizing a variety of different wheel antilock brake system designs. Technical and cost data will be compiled on available antilock brake systems offered for sale as well as on information on experimental systems. The data will be organized according to system capability, hardware installed, maintenance, cost, and related information. A limited number of passenger vehicles representing various types of wheel interlock brake system designs will be leased. Specified inspections, replacements, repairs, and instrumentation will be accomplished. Tests will be made using straight-line braking and braking in turns. Test data will be recorded in graph and table format relating longitudinal and lateral accelerations, and vehicle speed as a function of time with points of interest.

Wheel interlock systems used to identify problem areas will be evaluated, and photographic coverage of test runs furnished.

**DOT-HS-190-2-480**

**PEDESTRIAN ACCIDENT COUNTERMEASURES EX-  
PERIMENTAL EVALUATION**

Bio Technology, Inc.  
3027 Rosemary Lane  
Falls Church, Virginia 22042

7 May 73 to 25 Feb 74

\$32,537

This modification increases the number of participating cities and the number of test locations for behavioral evaluation by the inclusion of Akron and Toledo, Ohio.

**DOT-HS-137-3-661**

**MAINTENANCE OF OPERATIONS SYSTEMS  
DIRECTORY**

Genasys Corporation  
2011 Eye Street, N.W.  
Washington, D.C. 20006

15 April 73 to 14 April 74

\$14,971.97

Services are provided to support the Operations Systems Directory for 1 year. Computer runs of Operations Systems Directory programs will be submitted to the Federal Highway Administration computer facility in accordance with specific directions. Assistance is provided to maintain the NHTSA Thesaurus and personnel are provided to make programming modifications to Operations Systems Directory computer programs at the direction of NHTSA.

**DOT-HS-246-3-670**

**AN ACCIDENT TREND MODEL**

The Center for Environment & Man, Inc.  
275 Windsor Street  
Hartford, Connecticut 06120

16 May 73 to 17 May 74

\$57,408

This effort will develop a coherent accident trend model that provides functional relationships between each accident category and the various factors that are significant to that category. Factors will be identi-

ned which have an appreciable influence on accidents; motor vehicle accidents will be organized into related or homogeneous categories; factors likely to be related to each category of accident will be identified, and the mathematical concepts that express the relationships of the factors to the accidents will be explored. A coherent, quantitative model will be developed that relates each accident category to the various factors found significant, the model will be applied to historical data and an estimate made of the magnitude of the impact of any missing factors on the accuracy of the model; the model will be applied to show the effect of changes on the accident trends.

**DOT-HS-037-1-044**

#### **ALCOHOL SAFETY ACTION PROGRAM**

Maine Department of State  
Motor Vehicle Division  
242 State Street  
Augusta, Maine 04330

17 May 73 to 30 April 73

\$15,700

The purpose of this modification is to secure additional baseline data for the calendar years 1969, 1970, and 1971 for specified Baseline Data Tables.

**DOT-HS-204-3-672**

#### **EFFECTIVENESS OF THE FATAL ACCIDENT REDUCTION AND ENFORCEMENT (FARE) PROGRAM**

Small Business Administration  
1 Decker Square  
Suite 400, East Lobby  
Bala-Cynwyd, Pennsylvania 19004

21 May 73 to 20 Feb 74

\$71,395

The objective of this effort is to identify and assess the effectiveness of the Fatal Accident Reduction Enforcement (FARE) programs in the representative States and three representative cities. It will measure the effectiveness of FARE in reducing fatal crashes through the use of individual or combined countermeasures. FARE program objectives, operations, and evaluation approach will be reviewed, and an evaluation plan developed for the operational FARE program. The plan will be a detailed research design for evaluating the Fatal Accident Reduction Enforcement program as it is implemented in the FARE operational

sites. The research design will specify data requirements, the measures of effectiveness to be employed, and the countermeasures to be used along with criteria for their selection. The design will indicate the statistical analyses and administrative functions to be performed, and will include the community description of the project sites and baseline data to be used in the prospective analyses.

**DOT-HS-256-3-688**

#### **BINOCULAR AND MONOCULAR FIELD OF VIEW PERFORMANCE TEST**

Tracor/Jitco, Inc.  
1300 E. Gude Drive  
Rockville, Maryland 20851

13 June 73 to 13 Nov 73

\$24,912

Data will be obtained from new model passenger cars, trucks, and buses using different proposed binocular and monocular testing procedures to provide a data base to compare in-vehicle compliance techniques and establish performance requirements. The detailed specified procedures will be used to make various designated binocular and monocular horizontal and vertical measurements, and various vertical and horizontal angular and rearward measurements to derive the required data.

**DOT-HS-325-3-729**

#### **LABORATORY TESTING PROCEDURES**

Control Systems Research, Inc.  
1515 Wilson Boulevard  
Arlington, Virginia 22209

18 June 73 to 17 Sept 73

\$9,989

Laboratory procedures will be developed and documented for standards enforcement testing for Federal Motor Vehicle Safety Standard 119, Tires for Multipurpose Passenger Vehicles, Trucks, Buses, Trailers and Motorcycles. The laboratory test procedure will be consistent with current laboratory procedures for FMVSS 109/117 and Federal Register issued on July 3, 1972 (37 FR 13481). Two satisfactory demonstration tests will be performed prior to preparation of the final laboratory procedure. Tires to be tested are to be furnished by the contractor.

**DOT-HS-090-2-477**

**WEAVER PLATFORM BRAKE TESTER**

The Bendix Corporation  
Research Laboratories  
20800 Ten and One-Half Mile Road  
Southfield, Michigan 48076

11 May 73 to 13 Aug 73

\$7,451

This modification provides for conducting physical tests and evaluations of two additional vehicle brake test devices.

**DOT-HS-031-3-743**

**HSRI MODEL MM 1001 50TH PERCENTILE ANTHROPOMORPHIC-ANTHROPOMETRIC DUMMY**

University of Michigan  
260 Research Administration Building  
Ann Arbor, Michigan 48105

15 May 73 to 31 Aug 73

\$11,600

This will acquire HSRI Model 1001 50th percentile anthropomorphic-anthropometric crash test dummy, University of Michigan Highway Safety Research Institute Model No. MM 1001 developed under Contract MVMA 7205-C14. Materials to be completely assembled, adjusted, and packaged in such a manner that upon receipt they will be usable for crash testing.

**DOT-HS-230-3-674**

**SOURCES AND REMEDIES FOR RESTRAINTS SYSTEM DISCOMFORT AND INCONVENIENCES**

Man-Factors, Inc.  
4433 Convoy Street  
San Diego, California 92111

23 May 73 to 22 May 74

\$67,262

Guidelines will be developed and suggested regulatory language designed to eliminate or reduce the confusion found with many of the present motor vehicle restraint systems; the ease and convenience of their use will be improved; and the discomfort associated with the use of some restraint systems will be diminished or eliminated. A method for evaluating the human factors of automotive restraint systems will be developed as well

**DOT-HS-024-2-299**

**ACCIDENT INVESTIGATION IN NATO NATIONS**

Southwest Research Institute  
8500 Culebra Road  
San Antonio, Texas 78228

16 June 73 to 30 Sept 73

\$56,648

This modification provides for data preparation and analysis to test the practicability of the standardized accident investigation protocols with particular emphasis on the field operational procedures and specialized NATO accident report form. Critiques will be analyzed to ascertain the opinions of participants as to the applicability of the report form, problems encountered, and format revisions. A representative will accompany NATO teams to assess the participation of the teams and determine what problems exist. Findings and recommendations will be presented to a coordinating panel meeting. Plans will be developed for an accident investigation workshop.

**DOT-HS-009-1-009**

**DEVELOPMENT OF AN INTEGRATED VISION AND HEARING TESTING DEVICE**

System Development Corporation  
2500 Colorado Avenue  
Santa Monica, California 90406

5 June 73 to 30 April 74

\$26,436

This modification is to obtain further information concerning the relationships among visual and auditory performance measures and between these measures and driving records; investigates the feasibility of developing a cost-effective vision and hearing testing device for driver licensing purposes and, if warranted, develops and evaluates a new Integrated Vision/Hearing Testing Device (IVHTD). An exploratory research program will be conducted, a prototype IVHTD designed, a prototype vision/hearing tester designed, an evaluation study conducted, and a final



**DOT-HS-005-3-686**

**DEVELOPMENT OF TEST PROCEDURES FOR TESTING OF VEHICLES FOR CONFORMANCE WITH FEDERAL MOTOR VEHICLE SAFETY STANDARD 124, ACCELERATOR CONTROL SYSTEMS**

Dayton T. Brown, Inc.  
Church Street  
Bohemia, Suffolk County, New York 11716

1 June 73 to 31 July 73

\$9,353

A laboratory test procedure will be developed to satisfactorily test passenger cars, multipurpose passenger vehicles, trucks, and buses to all of the requirements of Federal Motor Vehicle Safety Standard No. 124, Accelerator Control Systems. A demonstration test will be made on a new 1973 standard-size car, one gasoline-driven truck, and one diesel-driven truck.

**DOT-HS-272-3-734**

**TIRE TREADWEAR TEST**

ATI (Automotive Testing, Inc.)  
P.O. Box 207, Rt. 36, Motor City  
Corriganville, Maryland 21524

18 June 73 to 19 Sept 73

\$15,222

A Uniform Quality Grading System (UQGS) for tires will be developed. Tests will be performed in two phases. In Phase I, three identical vehicles with drivers will be operated for 2400 miles in 400-mile segments for a total of 7200 miles on a treadwear course. In Phase II, three convoys, each composed of three vehicles, will be operated. Each convoy will consist of three identical vehicles of one of three specified suspension systems. Test course is 400 miles in length. Tests will be conducted in accordance with detailed specifications furnished by NHTSA. Tires, rims, and Tread Depth Device required to perform the tests will be furnished and delivered to the place of test by the Government.

**DOT-HS-046-2-468**

**FRONT END CRASH TESTS**

Dynamic Science  
Division of Ultrasystems, Inc.  
1800 West Deer Valley Drive  
Phoenix, Arizona 85027

No change

This modification provides for additional front end crash tests of an experimental safety vehicle to be impacted at zero degrees against a barrier at incremental speeds of 10 mph to 50 mph according to test requirements furnished by NHTSA.

**DOT-HS-105-3-680**

**COMPOSITE MATERIALS FOR AUTOMOBILE SIDE STRUCTURES—FEASIBILITY EVALUATION**

ITT Research Institute  
10 W. 35th Street  
Chicago, Cook County, Illinois 60616

29 May 73 to 28 May 74

\$98,663

A familiarization study will be conducted of the side impact problem with emphasis on the structural dynamic response of a vehicle being impacted laterally by another. A state-of-the-art survey will be conducted to identify candidate materials to improve side impact crashworthiness. An in-depth review will be made of construction and fabrication techniques. Structural elements will be designed and fabricated for use in certain tests, and specified tests planned, conducted, and evaluated in accordance with NHTSA requirements.

**DOT-HS-024-3-683**

**INTERCHANGEABILITY OF AUTOMOTIVE HEADLIGHTS**

Southwest Research Institute  
8500 Culebra Road  
San Antonio, Texas 78228

29 May 73 to 31 Dec 73

\$19,950

A study will be made to determine the benefits, detriments, and degree of retention of interchangeability of automotive headlamps. An investigation will be made of past practices of headlamp configurations and sizes as they relate to the effect on major parameters of headlighting. An analysis will be made of certain standards specified by NHTSA and the effects of the degree of headlamp standardization. Safety, cost, availability, maintenance, styling, and engineering

**DOT-HS-113-2-441**

### **SLED TESTS**

Minicars, Inc.  
35 La Patera Lane  
Goleta, California 93013

No change

\$49,045

This modification requires a minimum of 120 sled tests to be conducted during the development efforts of Tasks 2 and 3, and that during a portion of these tests and during the evaluation sled tests of Task 5, the three-dimensional motion of the occupant compartment during simulated frontal impact will be considered.

**DOT-HS-046-2-468**

### **ESV CRASH TESTS**

Dynamic Science  
Division of Ultrasystems, Inc.  
1800 West Deer Valley Drive  
Phoenix, Arizona 85027

31 May 73 to 3 Aug 73

\$69,379

This modification provides for acquisition of additional crash data through the use of a second ESV in a frontal barrier crash in accordance with Government approved procedure for flat barrier impact.

**DOT-HS-018-3-597**

### **OSE PERIODIC REPORTS SYSTEM**

Control Systems Research, Inc.  
1515 Wilson Boulevard  
Arlington, Virginia 22209

1 June 73 to 31 Oct 73

\$26,477

This modification provides for the operation and maintenance of the OSE Periodic Reports System for May through September 1973. OSE Periodic Reports as of March 31, 1973 will be examined to ascertain errors, omissions, and inconsistencies. Other FMVSS systems will be integrated into the OSE reports system. Existing software will be tested periodically to improve reliability of operation, and input and output format modifications will be accumulated for a one-time modification to software.

**NHTSA-325-3-681**

### **COMPUTER PROGRAMS FOR OFFICE OF DEFECTS INVESTIGATION DATA**

Control Systems Research, Inc.  
1515 Wilson Boulevard  
Arlington, Virginia 22209

1 June 73 to

\$69,900

An all-encompassing Defect Investigation reporting and recording system will be designed and developed. The existing vehicle owner computer letter program will be modified to utilize more detailed vehicle and tire data, convert existing data to the file, eliminate duplicated information, and design an investigatory case or engineering analysis output program. A program will be designed to store and retrieve manufacturer service bulletins and data. A program will be designed to store and retrieve investigatory cases and engineering analysis data. The existing campaign recall program will be modified to include a more rigid edit program and to eliminate duplicate information. A specialized retrieval program will be designed to retrieve data from each of the files to form a summary of information for one report.

**DOT-HS-064-3-687**

### **CORRELATION ROAD TEST**

Hodges Transportation, Inc.  
P.O. Box 234, No. Plaza Street  
Carson City, Nevada 89701

4 June 73 to 7 months after date of award or receipt of all GFE material.

\$57,832

Research will be initiated to determine the road performance and life of new tires that have been found to have anomalies, and the relation of these anomalies to highway safety. NDT will be evaluated and validated as a tool to determine and identify tire safety anomalies. A data base will be supplied from which MVSS-109 may be revised to reflect the state-of-the-art performance. A plan of work and methodology will be developed to derive information for the detailed tasks. Test procedures will be designed, and tests conducted according to detailed specifications established by NHTSA.

**DOT-HS-099-3-673**

**PASSENGER CAR PERISCOPE AND TRUCK MIRROR  
REARVIEW SYSTEMS**

Dunlap and Associates  
115 S. Oak Street  
Inglewood, California 90301

4 June 73 to 30 Nov 73

\$72,879

A study will be made to investigate all likely alternative mirror systems and concepts to those of the ongoing study. This study will elicit information on the effects of passenger obstruction on rearward viewing with certain non-periscopic systems, and comparisons of rearward viewing effectiveness with different systems during night driving. Vehicles with innovative rearward viewing systems will be examined. Vehicles previously tested during daylight will be evaluated under night driving conditions. Horizontal and vertical side and rearward fields of view will be mapped and evaluated according to specifications established by NHTSA.

**DOT-HS-311-3-596**

**ESV TEST**

Ford Motor Company  
Special Purpose Vehicle Operations  
19855 Outer Drive  
P.O. Box 1748  
Dearborn, Michigan 48121

No change

\$21,236

This modification provides a second ESV test vehicle and the necessary engineering, maintenance, and manufacturing support for its use in accident avoidance and crash testing.

**DOT-HS-032-1-036**

**SLED TESTS**

U.S. Department of Transportation  
Federal Aviation Administration  
Atlantic City, New Jersey 08405

No change

\$15,255

This modification provides for eight sled tests simulating rear-end collisions with the moving barrier at

tional rear-end collision tests at 30 mph. All tests will be made under various conditions specified by NHTSA.

**FH-11-7535**

**ALCOHOL SAFETY ACTION PROJECT**

Washtenaw County Board of Commissioners  
County Bldg., Main & Huron Streets  
Ann Arbor, Michigan 48104

No change

\$124,878

This modification provides for various changes in the Executive Summary Chart reflecting corrected costs of ASAP and revised budget.

**DOT-HS-361-3-745**

**BODY-VEHICLE INTERACTION EXPERIMENTAL  
STUDY**

Battelle Memorial Institute  
Columbus Laboratories  
505 King Avenue  
Columbus, Ohio

8 June 73 to 24 June 74

\$99,810

A study will be made to establish impact tolerance levels of the abdomen and legs of a standing pedestrian when struck by an automobile. Practical modifications will be established for vehicle impacting surfaces so that higher impact velocities can be tolerated. Methodology will be developed and tests made in various aspects specified by NHTSA. Materials will be investigated as possible candidates for a bumper covering, and a prototype bumper developed and used in a series of impact tests.

**DOT-HS-104-3-689**

**LEBOW MODEL 7610-107**

Lebow Associates, Inc.  
1728 Maplelawn Road  
Troy, Michigan 48064

8 June 73 to 18 Sept 73

\$13,732.80

This contract provides for the acquisition of one Lebow Model 7610-107 Brake Test Instrument System with modifications in accordance with specifications furnished by NHTSA. Spare parts and

**DOT-HS-031-3-637**

**DRIVER EXPOSURE RESEARCH STUDY**

The University of Michigan  
Office of Research Administration  
Research Administration Building  
North Campus  
Ann Arbor, Michigan 48105

11 June 73 to 30 June 73

\$8,110

A comprehensive program plan will be created for future research, data collections, and evaluations in the field of driving exposures. A symposium will be planned, participants selected, and arrangements made for active role of speakers, panel members, and other contributors.

**DOT-HS-099-3-705**

**IDENTIFICATION AND TEST OF PEDESTRIAN SAFETY MESSAGES FOR PUBLIC EDUCATION PROGRAMS**

Dunlop and Associates, Inc.  
One Parkland Drive  
Darien (Fairfield), Connecticut 06820

12 June 73 to 14 June 74

\$71,939

This research project will develop specific messages based on pedestrian accident research findings; identify feasible communication channels to reach the target group; and pretest the effectiveness of the messages.

**DOT-HS-031-3-722**

**ASAP BASELINE VOLUNTARY SURVEY**

The Regents of the University of Michigan  
260 Research Administration Building  
Ann Arbor, Michigan 48105

13 June 73 to 12 April 73

\$114,991

A study will be made to develop the U.S. contribution to an international study of the impact of volunteer measure programs on drinking and driving. The study will provide baseline data for comparison with ASAP roadside voluntary surveys; it will provide a national estimate of the number of drinking drivers

on the road, and data for comparison with other participating nations; and it will determine the impact of the NATO program. A new sampling procedure will be developed which will provide weighted national estimates; surveys will be made according to NHTSA specifications; and the resulting data analyzed.

**NHTSA-204-3-611**

**TRANSFORM MOTORCYCLE DATA INTO MAGNETIC TAPE MEDIUM**

Opportunity Systems, Inc.  
1330 Massachusetts Avenue, N.W.  
Washington, D.C. 20005

13 June 73 to 31 Aug 73

\$6,444

This modification provides for necessary extensive refinement of coding dictionaries.

**DOT-HS-032-1-036**

**ROLLOVER TESTS**

National Aviation Facilities Experimental Center  
Atlantic City, New Jersey 08405

14 June 73 to 1 Nov 73

\$91,827

This modification provides for completion of construction of new rollover test fixture, extension of the test track, and the conduct of 15 rollover tests according to specifications furnished by NHTSA.

**DOT-HS-034-3-717**

**PROBATION-DIAGNOSIS-REFERRAL SEMINARS AT 14 ASAP SITES**

Indiana University Foundation  
Post Office Box F  
Bloomington, Indiana 47405

15 June 73 to 19 June 74

\$69,996

Training will be provided for Alcohol Safety Action Project personnel concerned with the functions of probation, presentence investigation, diagnosis, referral, and rehabilitation of DWI offenders. Seminars will be conducted at each of 14 ASAP sites. Approximately 20 persons will be trained at each seminar. Detailed project schedules will be prepared.

**DOT-HS-146-3-711**

**CONTACT LOADS-EXPERIMENTAL STUDY**

Wayne State University  
Grants and Contract Administration  
5050 Cass  
Detroit, Michigan 48202

18 June 73 to 17 June 75

\$224,020

A study will be made to determine if the CALSPAN 3-Dimensional Crash Victim Simulator has the ability to duplicate drop tests conducted at TTI, and simulate additional experimental data derived from actual vehicle impact tests. A methodology plan will be developed, and the accuracy of the CAL 3-D simulation tested. An improved mathematical description of the contact force will be derived and incorporated in the CAL 3-D simulation. A computer routine will be devised which will integrate these values to obtain the velocities and displacements of each link. Magnitudes and directions of contact forces will be determined.

**DOT-HS-027-3-545**

**EFFECT OF CLUTCH CABLE BREAKAGE ON VEHICLE CONTROL**

General Testing Laboratories  
6840 Industrial Road  
Springfield, Virginia 22151

18 June 73 to 17 July 73

\$2,915.60

This modification provides for the design, installation and test of a device that will simulate sudden clutch cable breakage.

**DOT-HS-034-3-669**

**ALCOHOL MANPOWER DEVELOPMENT**

Indiana University Foundation  
P.O. Box F  
Bloomington, Indiana 47405

18 June 73 to 17 Dec 75

\$180,000

Seminars will be organized and conducted at 16 ASAP sites, one seminar for judges and one for prosecutors. Seminars will be conducted at 10 additional sites, at which one combined seminar will be for judges and

**DOT-HS-031-3-723**

**IMPROVED REAR SIGNALING AND LIGHTING**

The University of Michigan  
Office of Research Administration  
Research Administration Building  
Ann Arbor, Michigan 48105

18 June 73 to 30 June 74

\$

A study will be made to evaluate rear signaling systems for their ability to prevent specific types of rear-end accidents, to determine car-following behavior behind a vehicle equipped with an accelerator-position indicating signal, and to assess the reaction of drivers when a high-deceleration indicator light is observed on a lead vehicle. A model will be provided of specific types of rear-end crashes; the ability of a signal system to attract driver attention will be measured; and devices which have a potential safety benefit for rear signaling will be tested.

**DOT-HS-150-3-668**

**EFFECT OF MARIJUANA AND ALCOHOL ON VISUAL SEARCH PERFORMANCE**

The Regents of the University of California  
University of California, Los Angeles  
405 Hilgard Avenue  
Los Angeles, California 90024

18 June 73 to 17 June 74

\$149,916

A study will be made to investigate the effects of marijuana and alcohol on the driver's visual search processes by the use of eye movement recording techniques in an experimentally controlled situation. The data developed will be used to determine if these drugs have a significant effect on the driver's visual search and recognition capability which may result in accident causation. A driving situation will be simulated, and the information content of the roadway scene analyzed. Eye movement will be recorded to determine fixations. This and other data will be analyzed to determine if certain drugs or drug combinations affect the spatial distribution of eye move-

This contract provides for a visual inspection of approximately 66 assorted types and models of passenger cars for obvious violations of the applicable Federal Motor Vehicle Safety Standards (FMVSS).

#### **DOT-HS-020-2-290 IA**

##### **STANDARDS DEVELOPMENT**

National Bureau of Standards  
Law Enforcement Standards Laboratory  
Washington, D.C.

19 June 73 to 31 Dec 74

\$7,500

This modification extends the Interagency Agreement between the National Highway Traffic Safety Administration and the National Bureau of Standards Law Enforcement Standards Laboratory. The modification clarifies the schedule of performance on three standards: Evidential Breath Testers, Screening Breath Testers, and Breath Test Calibrating Units.

#### **DOT-HS-099-3-728**

##### **DEVELOPMENT OF MODEL REGULATIONS FOR PEDESTRIAN SAFETY**

Dunlap and Associates, Inc.  
One Parkland Drive  
Darien (Fairfield), Connecticut 06820

20 June 73 to 22 March 74

\$65,694

A set of model rules, regulations, codes, ordinances, and related procedures will be developed which are suitable for use by State and local governments to reduce pedestrian accidents within their jurisdiction. The model regulations will be supported by information regarding the physical/operational requirements of the countermeasures in the regulations; the actions needed to effect legislation, application, and enforcement; and public/official acceptance. The project will include analysis of countermeasures, development of support actions, assessment of public/official acceptance, and integration and development of model regulations.

\$11,514  
This research will determine the feasibility of providing antilock brakes for vehicles by developing suitable, special-property brake lining material. A research effort on brake materials and their friction/speed relationships will be continued.

#### **DOT-HS-024-3-731**

##### **AUTOMOTIVE DISC RECORDER—ENVIRONMENTAL TESTS**

Southwest Research Institute  
8500 Culebra Road  
Post Office Drawer 28510  
San Antonio, Texas 78284

21 June 73 to 21 Sept 73

\$15,960

A revolving automotive disc recorder has been developed by NHTSA. In this research effort a number of these automotive recorders will be installed in a large number of automobiles to obtain acceleration/time histories of crashes which may occur. This contract provides for environmental tests on some of the production units to assure that they will operate within NHTSA specifications. The disc recorders will be subjected to various temperature, shock, vibration, and humidity tests, as well as salt spray tests.

#### **DOT-HS-325-3-681**

##### **DATA PROCESSING SYSTEM**

Control Systems Research, Inc.  
1515 Wilson Boulevard  
Arlington, Virginia 22209

21 June 73 to 31 Mar 74

\$22,025

This modification provides for the operation and maintenance of the modernized and enlarged data processing systems described under the original contract.

**DOT-HS-342-3-678**

**MODEL 2500-2 SPECIAL TRIAXIAL FORCE TRANSDUCER**

R.J. Law Engineers, Inc.  
26341 W. Eight Mile Road  
Detroit, Michigan 48240

21 June 73 to 20 Dec 73

\$6,012.75

Procures one Model 2500-2 Special Triaxial Force Transducer.

**DOT-HS-350-3-707**

**ALCOHOL SAFETY ACTION PROGRAM LEVEL II GROUP DYNAMICS MODEL**

McBer and Company  
675 Massachusetts Avenue  
Cambridge, Massachusetts 02139

22 June 73 to 21 June 74

\$56,354

Approximately four ASAP staff members from each of four different States will be trained to be Power Motivation Trainers. An evaluation plan for testing the effectiveness of the Power Motivation Training will be designed, and materials will be provided for Power Motivation Training with DWI's.

**DOT-HS-339-3-726**

**THREAT DETECTION TRAINING PROGRAMS FOR CHILD PEDESTRIAN SAFETY**

Applied Science Associates, Inc.  
Box 158  
Valencia, Pennsylvania 16059

22 June 73 to 30 June 74

\$65,930

Research will be undertaken to formulate training specifications which incorporate behavior modification techniques to improve the search and detection behavior of children for threatening vehicles in a specific type of pedestrian accident situation; to develop a selected set of training programs in accordance with the specification; and to test the effectiveness of these programs in enhancing threat detection behavior. The project will be in three phases: the first phase will develop a detailed set of training specifications reflecting a behavioral analysis and an evaluation of behavior modification techniques; the

second phase will involve preparation of alternative training programs in a preliminary form; and the third phase will be concerned with pilot test evaluations of the developed programs and the development of a user guide.

**DOT-HS-364-3-757**

**ON-THE-ROAD DRIVING BEHAVIOR AND BREATH ALCOHOL CONCENTRATION**

Psychological Research Foundation of  
Vermont, Inc.  
P.O. Box 867  
Burlington, Vermont 05401

22 June 73 to 30 June 74

\$95,742

A study will be made to identify specific driving behaviors associated with different levels of BAC that may lead to accidents. The potential for improving the on-the-road detection of intoxicated drivers will be determined through visual observation procedures, sensing aids, or automated classification methods. The utility and validity of existing laboratory and simulator approaches to determine the effects of alcohol on real-world driving behavior will be assessed. A roadside experimental study will be conducted in two phases: phase I will include the experimental plan, site and stimulus selection, implementation of the sensing and recording equipment, and preliminary checkout; phase II will include data collection, analysis, and interpretation.

**DOT-HS-357-3-721 IA**

**PEDESTRIAN-BICYCLIST ACCIDENT DATA SAMPLING AND ANALYSIS PROGRAM**

Mr. E. L. Bittle  
L. G. Hanscom Field  
Bedford, Maine 01730

22 June 73 to 20 June 74

\$185,898

A pedestrian-bicyclist accident data sampling and analysis program will be developed to determine what types of pedestrian and bicycle-motor vehicle accidents occur and to estimate the number and relative frequencies of each type of accident. This portion of the program will include analysis of data requirements, preliminary systems design, data collection techniques, statistical design, information flow and automatic data processing specifications, measures of exposure, and implementation planning.



POSTAGE AND FEES PAID  
NATIONAL HIGHWAY TRAFFIC SAFETY  
ADMINISTRATION  
517

CENTRAL LIBRARY  
NOV 25 1973  
FBI - WASHINGTON

U.S. DEPARTMENT OF TRANSPORTATION  
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION  
Office of Administration  
WASHINGTON, D.C. 20590  
OFFICIAL BUSINESS  
Penalty For Private Use, \$300